DOCUMENT RESUME

ED 151 148 SE 023 095

AUTHOR	Caldwell, Lynton K.; Siddiqi, Toufiq A.
TITLE	Science, Technology, and Public Policy. A Guide to Advanced Study.
INSTITUTION	Indiana Univ., Bloomington. School of Public and Environmental Affairs.
SPONS AGENCY	National Science Foundation, Washington, D.C.
PUB DATE	Apr 72
NOTE	487p.; For related documents, see SE 023 093-094 and ED 045 366
EDRS PRICE	MF-$1.00 HC-$26.11 Plus Postage.
DESCRIPTORS	Bibliographies; Curriculum Guides; Policy Formation; *Public Policy; Science Education; *Sciences; Social Development; Study Guides; *Teaching Guides; *Technology

ABSTRACT

Presented are study guides for selected aspects of public policy for science and technology, and their impact upon society and public affairs. Each guide includes a topic outline, bibliography, and leading questions. The topics include: (1) Science and Technology as Social Forces; (2) The Organization of Science and Technology; and (3) Policy Problems of Science and Technology. (SL)

SED 70-03360

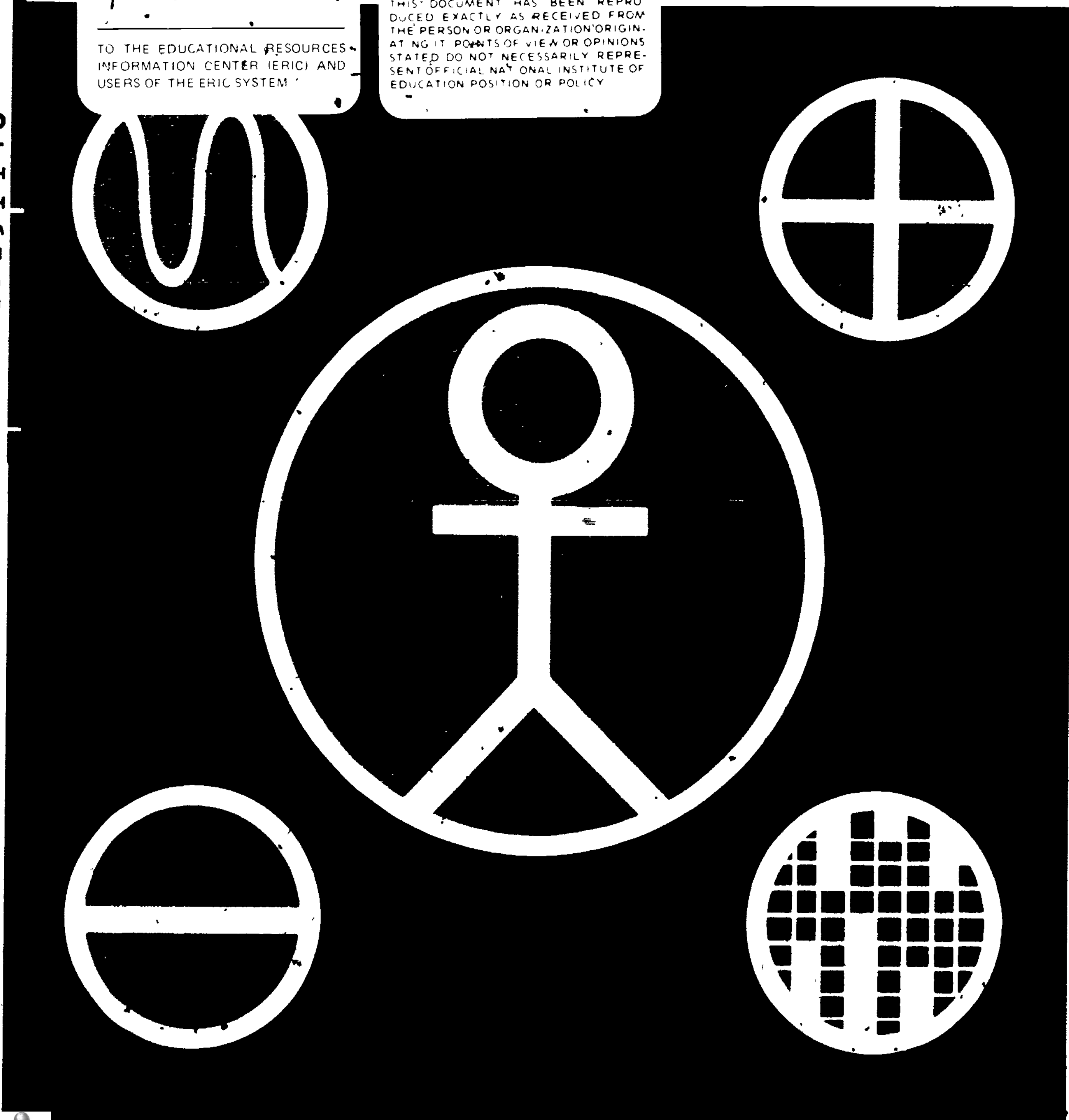
SCIENCE TECHNOLOGY AND PUBLIC POLICY

A GUIDE TO ADVANCED STUDY

PREPARED BY LYNTON K. CALDWELL AND TOUFIQ A. SIDDIQI

SCHOOL OF PUBLIC AND ENVIRONMENTAL AFFAIRS

INDIANA UNIVERSITY



SCIENCE, TECHNOLOGY, AND PUBLIC POLICY
A GUIDE TO ADVANCED STUDY

Prepared by

Lynton K. Caldwell

and

Toufiq A. Siddiqi

With the Assistance of
A Grant from the National
Science Foundation

School of Public and Environmental Affairs
Indiana University

Bloomington, Indiana 47401

April, 1972

THE STUDY OF PUBLIC POLICY FOR SCIENCE AND TECHNOLOGY

A Preliminary Statement

1 The following outlines of topics, questions, and readings are intended as guides to the study of selected aspects of public policy for science and technology, and their impact upon society and public affairs. This material is organized as a course appropriate to graduate or upper-division undergraduate instruction. Its scope is comprehensive and implies a high level of generality if the course were offered in a two-semester or three-quarter academic year. But each of the fifteen main topics into which the subject matter has been divided may be studied in depth and detail, and contains sufficient material for intensive study where desired.

2 The study guide was developed over a two year period, with assistance from the National Science Foundation, and has been revised following three years of experience. The course of study which it represents initially was experimental, the field of study being relatively new to universities in America or abroad. Outlines of similar or related courses offered in other universities were examined, not necessarily for the purpose of borrowing from or improving upon them, but rather to see how other institutions were dealing with the instructional problems of the field. If there is a one best way to study public policy for science and technology, the authors and revisers of this study guide have not found it. There are many approaches to the field of study. The advantages of some over others appear to depend in large measure upon the character of the institutions offering the instruction and upon the needs and backgrounds of the students.

3 The objective has therefore been to develop this study guide as a basic instructional facility rather than as a model course. The fifteen topics are, in effect, building blocks and can be put together in many different combinations. Individual topics can be taken apart and recombined, the keyed references providing reading lists for the new combinations. The study guide is easily adaptable to self-instruction; the topical abstracts, outlines, questions, and keyed references enable the student to follow a systematic course of learning without the direct assistance of textbooks or instructors.

4 An outgrowth of this development in curriculum construction has been a selective but comprehensive annotated bibliography in Science, Technology, and Public Policy prepared under a contract with the National Science Foundation. This three-volume compilation of references, distributed by the Foundation, covers material published in English between and including the years 1945 and 1970. Its use can assist further specialization in the field of study.

5 The field and focus of the study of public policy for science and technology have often been misconstrued. Students in this field are concerned primarily with public policy and secondarily with the subject matter of science and technology. They must, to the extent of their interest, become students of social or political science even though their prior training may have been in some other academic field. The study of public policy for science and technology is not intended as an answer to the need for an enlarged and improved public understanding of the substance and methods of the sciences. Efforts to bring understanding of science to college undergraduates or to citizens generally could contribute to better public policy for science and technology. But this task involves a different subject matter and focus and, ideally should be undertaken by the scientists themselves where the subject matter of their own disciplines is taught. In the field of policy studies the scientists are social scientists, although the assistance of professionals in the physical and biological sciences, medicine, and engineering is also required. As this volume indicates, scientists have been extensively involved in the shaping and criticism of science policy and in the application of science and technology. Scientists do, therefore, contribute to the study of public policy for science and technology even though relatively few of them may ever become actively involved in it as teachers or researchers.

6 One may concede that the process through which public policy is formulated and applied is an appropriate focus for study and yet question whether there is anything so distinctive about public policy for science and technology as to warrant special attention. It might be argued that the policy process may be studied by political scientists, but that study of the substance of policy belongs to the discipline primarily concerned with the subject matter of policy. For example, this reasoning would leave the study of the substance of weather modification to meteorologists, and of water pollution control largely to chemists. There can be no objection to this approach, provided that the natural scientist is willing to become a student of the social and political implications of his discipline. But the highly specialized character of modern science makes this interdisciplinary approach difficult.

7 Understanding of the problems of public policy in any substantive field requires a synthesis of knowledge of both the substance and processes of policy. This synthesis can be achieved in several ways. It is possible to achieve it largely because there is available to the student extensive policy-oriented writings by scientists themselves and by nonscientists well-grounded in the scientific aspects of policy issues. Synthesis may further result from the various forms of intellectual interchange between students of the processes of public policy-making and administration, and students of the social implications of science and technology.

8 The intrinsic importance of science and technology as subjects for policy studies depends upon their significance in the shaping of human societies. The tremendous impact of science and scientific technology on the modern world is now generally recognized. But, until recently, the effects have been widely assumed to be beneficial and to require no special attention. Since 1945, however, the hitherto small stream of critical comment on the uses and effects of science and technology has swollen to Amazonian proportions. Science and technology have become major topics for policy consideration in all industrial societies, in all modern governments, and in international affairs. Dangers of the overuse, underuse, and misuse of science are becoming matters of public concern. And at long last, the universities have begun to recognize their own responsibilities not only for advancing understanding of science itself, but also for advancing public understanding of its impact upon society. It is not easy to fit the study of public policy for science and technology into the conventional disciplinary structure of universities. But the great importance of the issues with which this aspect of policy study is concerned gives hope that this task, which implies new relationships among the disciplines, will somehow be accomplished.

A NOTE ON THE REVISED VOLUME

1 Following the printing of 500 copies of Volume I of Science, Technology, and Public Policy in 1968, requests for copies rapidly reduced the supply. Approximately 250 copies were distributed from Indiana University to colleges and universities, government agencies, and individuals teaching or organizing courses in science, technology, and public policy. An additional 100 copies were distributed by the National Science Foundation, and the balance were used at Indiana University and Purdue University for instructional purposes. Within two years, the Volume was out of print, except for a small supply for classroom use.

2 Three years' experience with Volume I suggested the following changes in its organization and content. A new Topic 13, Technological Forecasting and Assessment, has been added, and former Topics 09, International Technoscientific Organization, and 12, International Technoscientific Cooperation, have been combined under the latter heading. The fifteen topics are now equally divided among the three principal sections. Bibliographical material has been almost doubled, and the selections for basic readings have been extensively revised. The wording of the title has been revised; study guide being substituted for syllabus, as more descriptive of the Volume. This volume is a revision and expansion of the first of a two volume syllabus on Science, Technology and Public Policy prepared with the assistance of a grant from the National Science Foundation. This publication, in its revised form, will appear as two separate but related study guides with the volume numbers dropped. The original Volumes I and II were published by the Department of Political Science at Indiana University.

3 The authors gratefully acknowledge the helpful suggestions of users in the revision of this work. Appreciation is also expressed to the National Science Foundation for a grant of funds to assist revision and reprinting. The authors also express their gratitude to Hal Kibbey, Jan Lundy, May Lee, Mary Celenko, and staff of the Indiana University Libraries and the Indiana University Printing Plant for their assistance in the project.

TABLE OF CONTENTS

SCIENCE AND TECHNOLOGY AS SOCIAL FORCES

The five topics of this section introduce the student to the study of the effects of science and technology in modern society and afford background for the remainder of the course. It is hardly feasible to consider public policy for science and technology without some knowledge of what the terms "science" and "technology" mean, how they are related, and how they are different. This defining or clarifying of concepts is the substance of Topic 01. Science is explored in Topic 02 as an historical aspect of Western culture that has evolved into an autonomous universal culture of its own. Topic 03 is concerned with the ways in which science and science-based technology reshape traditional culture and give rise to problems that society attempts to solve by bringing science and technology under some form of public control, and by reshaping domestic, economic, educational, and legal institutions to conform to the impact of science and technology. Topic 04 describes science as an occupation, examines the characteristics of science-based fields, such as engineering and medicine, and analyzes the way in which scientific skills are utilized for technological purposes. Topic 05 outlines the impact of science on general education and on the preparation of scientific workers, and considers means to enlarge the public understanding of science. The concept "public policy" is not analyzed in this section. It may be sufficient to state here that public policy in the context of this syllabus means the choices that the public really makes through the action or inaction of government. Public policy as used in these topics is what government does, not necessarily what the law is presumed to imply, or what presidents, legislators, or citizens generally assert to be public policy. Public policy is therefore an imprecise concept and must receive a more rigorous and penetrating analysis before it can be given a clearer definition.

TOPIC 01 THE MEANINGS OF SCIENCE AND TECHNOLOGY

This topic provides an examination of science as an intellectual and social endeavor. Science changes man's view of reality and enlarges his ability to cope with this reality through technology. It thus becomes a social force capable of permeating all aspects of human life. Social institutions and formalized expressions of human experience in religion, art, philosophy, and law, have been unsettled, modified, and sometimes destroyed by force of scientific knowledge. Science as a way of thinking and of perceiving is therefore a continuing challenge to established beliefs, traditions, and authorities. It affects the conceptual and institutional bases of society and government, and inevitably becomes a factor in politics, notably in the shaping of public law and administration.

Although technology is as old as the arts of tool-making, ritual, and warfare, it has now become the major means for transferring scientific thought into social action. But technology is not merely a vehicle for science-based innovation; it is also a powerful force for the advancement of science. Instrumentation and refined research techniques are essential to the development of modern science. Radio telescopes, electron microscopes, and gas chromatography illustrate the dependence of advances in science upon advances in technology. Although separable in principle, science and technology in the more advanced industrial societies of the modern world are merged into a technoscientific complex of unprecedented power. Control of the transforming power of science-based technology thus becomes the object of competition among groups and individuals representing differing interests, values, and assumptions. The consequences of this political or policy-shaping competition are of great social importance, especially because of the destructive potential of technoscientific power and the need for organized social effort to maximize its beneficial effects.

The culture of advanced science and technology that is emerging in the late 20th century requires for its management widespread understanding of science and technology. Technoscientific society is structured by complex interdependent systems. Informed and intelligent cooperation is necessary to make these systems work. To direct and control the powers of science and technology it is necessary to understand their natures, requirements, and relationships. To manage these powers for human welfare also requires understanding of human needs and values. And so examination of the meanings of science and technology, and of the significance of these meanings for society is a logical point of departure for the study of public policy for science and technology.

TOPIC 01 THE MEANINGS OF SCIENCE AND TECHNOLOGY

Selected Basic Readings:

Brooks, Harvey. "Applied Science and Technological Progress," Science, CLVI (June 30, 1967), 1706-1712.

Kranzberg, Melvin. "The Unity of Science-Technology," American Scientist, LV (March, 1967), 48-66.

McLachlan, Dan, Jr. "A Guess as to What Is Science," Physics Today, XIV (June, 1961), 22-27.

Morison, Robert S. "Science and Social Attitudes," Science, CLXV (July 11, 1969), 150-156.

Price, Derek J. de Solla. The Differences between Science and Technology. Detroit, Michigan: Thomas Alva Edison Foundation, 1968, 16.

Supplementary and Substitute Readings:

Caldwell, Lynton K., ed. Science and Public Policy in the American University. Bloomington: Indiana University Program in the Public Administration of Science and Technology, 1969, 55.

Conant, James B. "Scientific Principles and Moral Conduct," American Scientist, LV (September, 1967), 311-328.

Impact of Science on Society. "Non-Scientists Dissect Science," Impact of Science on Society, XIX (October-December, 1969), 305-404.

Malik, Charles H. "The Limitations of Natural Science," Impact of Science on Society, XIX (October-December, 1969), 377-386.

Polanyi, Michael. "The Growth of Science in Society," Minerva, V (Summer, 1967), 533-545.

Ziman, John M. Public Knowledge: The Social Dimension of Science. London: Cambridge University Press, 1968, 154.

TOPIC 01 THE MEANINGS OF SCIENCE AND TECHNOLOGY

TOPICAL OUTLINE	REFERENCE KEY
I. The Meanings of Science	77, 78, 137, 139, 163, 175, 176, 179
A. Science as knowledge	158, 163, 176, 178
1. What knowledge is scientific?	53, 171
2. Definitions of "the sciences"	12, 48, 113
a. Hard and soft science	
b. Natural and social science	11, 58, 64, 91, 96, 107, 133
c. Physical and life science	50, 166
d. Pure and applied science	21, 26, 129
e. Theoretical and experimental science	11, 113
f. True and false science	
3. Cultural basis of definitions (cf. Topic 02)	138
4. Changing configurations of science	97, 159
a. Concept of the unity of science	170
b. Relationships among the sciences	77
c. Emergence of new sciences	77
B. Science as method of thought	32, 108, 109, 169, 175, 178, 179
1. Is there a scientific method?	7, 12, 86, 113 157, 161, 163
a. Method as a general concept	88, 104
b. Differences among methods, theories, and techniques	
c. Reductionism and synthesis	97
d. "Strong inference" as a general method	167
2. Limitations of scientific method	106, 144, 164, 174
a. Limits of contemporary technique	
b. Intrinsic limitations of science	7, 53, 95, 127
c. Is science fully defined by method?	

3. Relationship to philosophy	74, 114
a. Independence of science from philosophical dogma	15, 61
b. Science and philosophical values	27, 34, 129
II. The Meanings of Technology	41, 48
A. Technology as knowledge of "how"	23, 24, 1[illegible] 150
1. Scope and varieties of technique	
2. Technique and skill	45
3. Pre-scientific technique	
4. Limitations of technique without science	
B. Technology as an operating system (cf. Topic 03)	136, 141, 149, 162
1. Evaluation of technological interrelatedness	49, 59, 62
2. Technology and the economy	43, 54, 110
3. Science as a generator of technology	
4. Advent of "the technological society"	45, 84, 148, 177
III. Interrelations between Science and Technology	16, 54, 67, 68, 99, 145, 150
A. Conceptually distinct, but often practically related	1, 48, 56, 115, 137
1. Relationships in ancient societies	43, 165
a. Modern definitions are not applicable	
b. Priestly "technoscience" of Egypt	43
c. Science in Greece and China	89
d. Roman science and technology	
2. Relationships in Western Europe	42, 136, 137
a. Legacy of Aristotelianism	
b. Influence of alchemy	
c. Science and technology in the Islamic world	
d. Renaissance and Reformation	
e. Explosive fusion of science and technology	66, 119, 154

B. Symbiotic relationship of modern science and technology — 42, 44, 48, 67, 68, 140

1. Dependence of science upon technology — 46, 123
   a. Instrumentation
   b. Procedures of verification
   c. Preparation of materials
   d. Organization and recording of information
   e. Storage and dissemination of information
   f. Stimulation of scientific research
2. Dependence of technology upon science — 8, 21, 23, 24, 53, 85
   a. Knowledge of properties of materials
   b. Knowledge of sources and properties of energy
   c. Predicting the behavior of natural forces
   d. Opening the way to new technologies — 49, 124
   e. Legitimizing technological innovation
   f. Translating science into technology--the processes of invention and innovation (cf. Topic 15)

C. Relationships of science and technology to engineering — 121

IV. Public Understanding of Science and Technology — 31, 33, 57, 82, 90, 100, 102, 179

A. Need for public understanding — 19, 81, 126, 128, 131, 132

1. Full participation in modern society — 25, 76
2. Intelligent exercise of citizenship — 4, 83
3. Realism in personal and social decisions — 73
4. Protection against organized irrationality — 14, 55
5. Maximizing the benefits of science — 23, 79

B. Distorted or erroneous opinions — 18, 111, 151

1. Science and technology as magic — 41, 130
   a. Undue reliance on science to correct rather than to prevent human errors

b. Ignorance of conditions needed for advancement of science
c. Failure to respect the rationality of science
2. Science as servant of technology
a. Science valued not as teacher, but as servant of desires
b. Basic research devalued
c. Emphasis on problem-solving, technological applications — 124
d. Scientific creativity distorted
3. Science as theology--scientism — 41, 156
a. Science as absolute truth
b. Mystique of science and scientists — 106
c. Optimistic rejection of tradition
d. Pessimistic acceptance of diabolism

C. Dangers of misunderstood science — 20, 75, 151, 174
1. Ideological exploitation of popular naivete — 151
a. Theological rationalizations
b. Moralist distortions
c. Political scientific myths
d. Democratic biases — 117
2. Uncritical acceptance of allegedly science-based technology — 84, 148, 174
a. Technological determinism
b. Science used to rationalize techno-political choice — 71, 117
c. Insufficient examination of consequences — 118
d. Neglect of criteria for scientific and technological choice — 147, 151
e. Failure to provide safeguards for use of science and technology (cf. Topic 03)

D. Efforts toward public understanding--the United States — 142, 152
1. Educational institutions (cf. Topic 05) — 5, 10, 13, 35, 44
a. Science in the common schools
b. Understanding of science and technology as tasks of higher education
c. Science policy as a field of study — 28, 39, 70, 91, 98

2. Mass media	22, 69, 125
a. The role of the science writers	29, 30, 51, 72, 116, 120
b. Opportunities and limitations	40, 122
c. Dangers of over-popularization.	37, 87
3. Direct communication between the scientist and the public	6, 17, 80, 134
a. Through newspapers, popular journals, and books	9, 52, 75, 94
b. Lectures	60
c. Use of radio and television.	101
4. Governmental agencies (cf. Topics 06 and 11)	
a. Linear, "mission"-oriented role of most government information services	63
b. Policy review as a function of the Congress	63
c. Fact finding and policy review of ad hoc executive committees and commissions	
d. Roles of the National Science Foundation and the National Academies of Sciences and Engineering	
5. Professional organizations (cf. Topic 04)	
a. Public information as a secondary function of scientific and professional societies: e.g., American Chemical Society, American Medical Association	102
b. Organizations for public information: e.g., Atomic Scientists, Scientists Institute for Public Information	36
6. Associations of interested individuals for the purpose of planning or publicizing science-based remedies for such problems as overpopulation, radioactive fallout, wildlife conservation, and disease prevention	

BIBLIOGRAPHY

General References: Articles

1. Agassi, Joseph. "The Confusion between Science and Technology in the Standard Philosophies of Science," Technology and Culture, VII (Summer, 1966), 348-366.

2. Albrecht-Carrie, Rene. "Of Science, Its History, and the Teaching Thereof," Scientific Monthly, LXXIII (July, 1951), 16-24.

3. Almond, Gabriel. "Public Opinion and Space Technology," Public Opinion Quarterly, XXIV (Winter, 1960), 553-572.

4. Aron, Raymond. "The Education of the Citizen in Industrial Society," Daedalus, XCI (Spring, 1962), 249-263.

5. Ashby, Eric. "Dons or Crooners," Science, CXXXI (April 22, 1960), 1165-1170.

6. Asimov, Isaac. "View from a Height," Chemical and Engineering News, XLIII (May 3, 1965), 90-93.

7. Auger, Pierre. "Limits to Science," Bulletin of the Atomic Scientists, XXI (November, 1965), 21-22.

8. Barnes, Carl E. "To Promote Invention," International Science and Technology, Number 60 (December, 1966), 67-73.

9. Bates, Marston. "The Criticism of Scientific Books," Science, CXV (April 18, 1952), 4[illegible]-409.

10. Baum, Werner A. "Education for the Emerging Scientific Culture," Educational Record, XLIII (January, 1962), 44-47.

11. Beck, Lewis W. "The 'Natural Science Ideal' in the Social Sciences," Scientific Monthly, LXVIII (June, 1949), 386-394.

12. Benjamin, A. Cornelius. "On Defining 'Science'," Scientific Monthly, LXVIII (March, 1949), 192-198.

13. Bertalanffy, Ludwig von. "Philosophy of Science in Scienfific Education," Scientific Monthly, LXXVII (November, 1953), 233-239.

14. Bibby, Cyril. "Science as an Instrument of Culture," Nature, CCII (April 25, 1964), 331-333.

15. Born, Max. "The Concept of Reality in Physics," Bulletin of the Atomic Scientists, XIV (October, 1958), 313-321.

16. Boxer, L. W. "Interaction of Technologies," Nature, CCVII (September 11, 1965), 1121-1125.

17. Bragg, Lawrence. "The Art of Talking about Science," Science, CLIV (December 30, 1966), 1613-1616.

18. Brain, Walter R. "Science and Antiscience," Science, CXLVIII (April 9, 1965), 192-198.

19. Bronowski, Jacob. "The Educated Man in 1984," Advancement of Science, XII (December, 1955), 301-306.

20. ________. "The Logic of Nature," Political Quarterly, XXVI (July-September, 1955), 258-266.

21. Brooks, Harvey. "Applied Science and Technological Progress," Science, CLVI (June 30, 1967), 1706-1712.

22. Bulletin of the Atomic Scientists. "American Society of Newspaper Editors Reports on Atomic Information Problems," Bulletin of the Atomic Scientists, IV (July, 1949), 211-212; 217.

23. Bunge, Mario. "Technology as Applied Science," Technology and Culture, VII (Summer, 1966), 329-347.

24. Caine, Sydney. "Education for Development," Advancement of Science, XIV (December, 1957), 191-200.

25. Calder, Ritchie. "Common Understanding of Science," Impact of Science on Society, XIV (Number 3, 1964), 179-195.

26. Caldin, Edward F. "Science in Society: The Fundamentals," Endeavour, V (April, 1946), 70-73.

27. ________. "The Values of Science," Endeavour, V (October, 1946), 160-163.

28. Caldwell, Lynton K. "Some Problems of Curriculum Development," in Science and Public Policy in the American University, ed. by Lynton K. Caldwell. Bloomington: Indiana University Program in the Public Administration of Science and Technology, 1969, 36-44.

29. Carey, Frank. "Reporting Science," Science, CXV (April 18, 1952), 409-412.

30. Cohn, Victor. "Are We Really Telling the People about Science?" Science, CXLVIII (May 7, 1965), 750-753.

31. Conant, James B. "The Scientific Education of the Layman," Yale Review, XXXVI (September, 1946), 15-36.

32. ________. "Scientific Principles and Moral Conduct," American Scientist, LV (September, 1967), 311-328.

33. Couderc, Paul. "An Antidote for Anti-Science," Impact of Science on Society, XXI (April-June, 1971), 173-179.

34. Crisman, Paul. "Causation, Chance, Determinism, and Freedom in Nature," Scientific Monthly, LXI (December, 1945), 455-464.

35. Dart, Francis E. and Panna Lal Pradhan. "Cross-Cultural Teaching of Science," Science, CLV (February 10, 1967), 649-656.

36. Davis, Watson. "Science Service and the Dissemination of Science," AIBS Bulletin (BioScience), VIII (November, 1958), 21-23.

37. Decker, Fred W. "Scientific Communications Should Be Improved," Science, CXXV (January 18, 1957), 101-105.

38. Dedijer, Stevan. "The Science of Science: A Programme and a Plea," Minerva, IV (Summer, 1966), 489-504.

39. Denny, Brewster C. "Science and Public Policy: A Literature in Search of a Field," Public Administration Review, XXV (September, 1965), 239-248.

40. Dick, William E. "Science and the Press," Impact of Science on Society, V (September, 1954), 143-173.

41. Dooley, D. J. "Science as Cliche, Fable, and Faith," Bulletin of the Atomic Scientists, XV (November, 1959), 372-375.

42. Drucker, Peter F. "The First Technological Revolution and Its Lessons," Technology and Culture, VII (Spring, 1966), 143-151.

43. ________. "The Technological Revolution: Notes on the Relationship of Technology, Science, and Culture," Technology and Culture, II (Fall, 1961), 342-351.

44. Dupree, A. Hunter. "Public Education for Science and Technology," Science, CXXXIV (September 15, 1961), 716-718.

45. Ellul, Jacques. "Technique, Institutions, and Awareness," American Behavioral Scientist, XI (July-August, 1968), 38-42.

46. Feibleman, James K. "Importance of Technology," Nature, CCIX (January 8, 1966), 122-125.

47. ________. "The Philosophy of Tools," Social Forces, XLV (March, 1967), 329-337.

48. ________. "Pure Science, Applied Science, Technology, Engineering: An Attempt at Definitions," Technology and Culture, II (Fall, 1961), 305-317.

49. Fishlock, David. "The 'Fall-Out' from the Space Race," New Scientist, XVIII (May 30, 1963), 480-481.

50. Fitzgerald, John J. "Physical Science and the Objectives of the Scientist," Physics Today, V (October, 1952), 17-22.

51. Fraley, Pierre C. and Earl Ubell. "Science Writing: A Growing Profession," Bulletin of the Atomic Scientists, XVIII (June, 1962), 32-33.

52. Friendly, Alfred. "Scientists Meet the Press," Bulletin of the Atomic Scientists, XII (November, 1956), 338-340.

53. Gerard, Ralph W. "The Scope of Science," Scientific Monthly, LXIV (June, 1947), 496-512.

54. Gibbons, M. and C. Johnson. "Relationship between Science and Technology," Nature, CCXXVII (July 11, 1970), 125-127.

55. Gomer, Robert. "Vox Populi," Bulletin of the Atomic Scientists, XVIII (June, 1962), 32-33.

56. Hall, A. Rupert. "Historical Relations of Science and Technology," Nature, CC (December 21, 1963), 1141-1145.

57. Handlin, Oxcar. "Science and Technology in Popular Culture," Daedalus, XCIV (Winter, 1965), 156-170.

58. Haring, Douglas G. "Science and Social Phenomena," American Scientist, XXXV (July, 1947), 349-363.

59. Hearle, J. W. S. "Internation of Technologies," Nature, CCVII (September 18, 1965), 1229-1232.

60. Hill, John W. and James E. Payne. "Scientists Can Talk to the Layman," Science, CXVII (April 17, 1953), 403-405.

61. Hinshelwood, Cyril. "The Internal and the External Worlds," Nature, CLXXXIV (December 12, 1959), 1834-1838.

62. Holliday, L. "Interaction of Technologies," Nature, CXCVII (January 19, 1963), 222-226.

63. Hughes, Donald J. "Positive Aspects of the Release of Secret Information," Bulletin of the Atomic Scientists, XII (May, 1956), 169-172.

64. Hull, Clark L. "A Primary Social Science Law," Scientific Monthly, LXXI (October, 1950), 221-228.

65. Impact of Science on Society. "Non-Scientists Dissect Science," Impact of Science on Society, XIX (October-December, 1969), 305-404.

66. Kantrowitz, Arthur. "The Test: Meeting the Challenge of New Technology," Bulletin of the Atomic Scientists, XXV (November, 1969), 20-24.

67. Kranzberg, Melvin. "The Disunity of Science-Technology," American Scientist, LVI (Spring, 1968), 21-34.

68. ________. "The Unity of Science-Technology," American Scientist, LV (March, 1967), 48-66.

69. Krieghbaum, Hillier. "Public Interest in Science News," Science, CXXIX (April 24, 1959), 1092-1095.

70. Lasswell, Harold D. "Must Science Serve Political Power?" American Psychologist, XXV (February, 1970), 117-123.

71. ________. "The Political Science of Science," American Political Science Review, L (December, 1956), 961-979.

72. Lessing, Lawrence. "The Three Ages of Science Writing," Chemical and Engineering News, XLI (May 6, 1963), 88-92.

73. Lilienthal, David E. "Science and Man," Chemical and Engineering News, XXXVI (September 29, 1958), 114-124.

74. Lindsay, Robert B. "Physics--To What Extent Is It Deterministic?" American Scientist, LVI (Summer, 1968), 93-111.

75. Lynch, Russell G. "Linguistic Barriers in Science Writing," AIBS Bulletin (BioScience), XVI (November, 1966), 802-804.

76. McCurdy, Richard C. "Public Must Be Literate in Science," Chemical and Engineering News, XXXVI (November 3, 1958), 62-67; 99.

77. McLachlan, Dan, Jr. "A Guess as to What Is Science," Physics Today, XIV (June, 1961), 22-27.

78. Malik, Charles H. "The Limitations of Natural Science," Impact of Science on Society, XIX (October-December, 1969), 377-386.

79. Mathewson, James H. "Science for the Citizen: An Educational Problem," Science, CXXXVIII (December 28, 1962), 1375-1379.

80. Mead, Margaret. "Closing the Gap between the Scientists and the Others," Daedalus, LXXXVIII (Winter, 1959), 139-146.

81. Michael, Donald N. "The Space Age and American Public Opinion," Public Opinion Quarterly, XXIV (Winter, 1960), 573-582.

82. Morison, Robert S. "Science and Social Attitudes," Science, CLXV (July 11, 1969), 150-156.

83. Muller, Hermann J. "The Role of Biology in General Education," AIBS Bulletin (BioScience), XIII (August, 1963), 22-30.

84. Mumford, Lewis. "Technics and the Nature of Man," Nature, CCVIII (December 4, 1965), 923-928.

85. ________. "Technics and Science," Impact of Science on Society, II (January-March, 1951), 10-11.

86. Nagel, Ernest. "The Methods of Science: What Are They?" Can They Be Taught?" Scientific Monthly, LXX (January, 1950), 19-23.

87. Nelson, Norman E. "Science and the Irresponsible Imagination," Yale Review, XLIII (September, 1953), 71-88.

88. Novak, Alfred. "Scientific Inquiry," AIBS Bulletin (BioScience), XIV (October, 1964), 25-28.

89. Oldham, C. H. G. "Science in China's Development," Advancement of Science, XXIV (June, 1968), 481-487.

90. Oppenheimer, J. Robert. "The Age of Science: 1900-1950," Scientific American, CLXXXIII (September, 1950), 20-23.

91. Orlans, H. "Social Science Research Policies in the United States," Minerva, IX (January, 1971), 7-31.

92. Parsons, Talcott. "The Institutionalization of Scientific Investigation," in The Sociology of Science, ed. by Bernard Barber and Walter Hirsch., New York: Free Press of Glencoe, 1962, 7-15.

93. Piel, Gerard. "Need for Public Understanding of Science," Science, CXXI (March 4, 1955), 317-322.

94. Pigman, Ward. "Science at Bay," Chemical and Engineering News, XXXI (February 16, 1953), 652-657.

95. Planck, Max. "The Meaning and Limits of Exact Science," Science, CX (September 30, 1949), 319-327.

96. Polanyi, Michael. "The Growth of Science in Society," Minerva, V (Summer, 1967), 533-545.

97. ________. "Scientific Outlook: Its Sickness and Care," Science, CXXV (March 15, 1957), 480-484.

98. Price, Derek J. de Solla. The Diferences between Science and Technology. Detroit, Michigan: Thomas Alva Edison Foundation, 1968, 16.

99. ________. "Educating for the Scientific Age," Bulletin of the Atomic Scientists, XXIV (October, 1968), 26-32.

100. ________. "The Science of Science," Bulletin of the Atomic Scientists, XXI (October, 1965), 2-8.

101. Reid, Robert W. "Television Producer and Scientist," Nature, CCXXIII (August 2, 1969), 455-458.

102. de Reuck, Anthony V. S. "Popularizing Science," Nature, CCIII (July 25, 1964), 340-341.

103. Rickover, Hyman G. "A Humanistic Technology," Nature, CCVIII (November 20, 1965), 721-726.

104. Robinson, Robert. "Science and the Scientist," Advancement of Science, XII (September, 1955), 137-147.

105. Sarton, George. "Introductory Essays," in A Guide to the History of Science. Waltham, Massachusetts: Chronica Bontanica, 1952, 3-71.

106. Sayre, Anne. "The Scientific Method in Human Affairs," Bulletin of the Atomic Scientists, XI (October, 1955), 295-296.

107. Scates, Douglas E. "The Parallel Roles of Physical and Social Science," Scientific Monthly, LXIV (January, 1947), 14-20.

108. Schmidt, Paul F. "Models of Scientific Thought," American Scientist, XLV (March, 1957), 137-149.

109. ________. "Some Merits and Misinterpretations of Scientific Method," Scientific Monthly, LXXXII (January, 1956), 20-24.

110. Schon, Donald A. "The Fear of Innovation," International Science and Technology, Number 59 (November, 1966), 70-78.

111. Seaborg, Glenn T. "The New Optimism," Futurist, III (December, 1969), 157-160.

112. Seeger, Raymond J. "On the History and Philosophy of Science," American Scientist, LIV (April, 1956), 151-157.

113. Siever, Raymond. "Science: Observational, Experimental, Historical," American Scientist, LVI (Spring, 1968), 70-79.

114. Simpson, George G. "The Problem of Plan and Purpose in Nature," Scientific Monthly, LXIV (June, 1947), 481-495.

115. Skolimowski, Henryk. "The Structure of Thinking in Technology," Technology and Culture, VII (Summer, 1966), 371-383.

116. Skrotsky, Nicolas. "The Role of Scientific Journalists in Intermediaries between Science and the Non-Specialist: The Task of the Press in Popularizing Science in an Era of Rapid Scientific Growth," in Conference on the Communication of Scientific and Technical Knowledge to Industry, 1963. Paris: Organization for Economic Cooperation and Development, Directorate for Scientific Affairs, 1965, 161-166.

117. Smyth, Henry D. "From X-Rays to Nuclear Fission," American Scientist, XXXV (October, 1947), 485-501.

118. Starr, Chauncey. "Social Benefit versus Technological Risk," Science, CLXV (September 19, 1969), 1232-1238.

119. Stevenson, Earl P. "Creative Technology," Scientific Monthly, LXXVI (April, 1953), 203-206.

120. Sullivan, Walter. "Writing Science for the Public," Physics Today, XXIII (August, 1970), 51-53.

121. Swann, William F. G. "Engineering and Pure Science," Physics Today, IV (June, 1951), 9-17.

122. Thistle, M. W. "Popularizing Science," Science, CXXVII (April 25, 1958), 951-955.

123. Thompson, Peter. "Traces: Basic Research Links to Technology Appraised," Science, CLXIII (January 24, 1969), 374-375.

124. Townes, Charles S. "Quantum Electronics, and Suprise in the Development of Technology," Science, CLIX (February 16, 1968), 699-703.

125. Ubell, Earl. "Covering the News of Science," American Scientist, XLV (December, 1957), 330A-350A.

126. Weaver, Warren. "The Imperfections of Science," American Scientist, XLIX (March, 1961), 99-113.

127. ________. "Science and the Citizen," Science, CXXVI (December 13, 1957), 1225-1229.

128. ________. "Why Is Science Important?" Chemical and Engineering News, XXXIX (February 13, 1961), 144-148.

129. Weinberg, Alvin M. "The Axiology of Science," American Scientist, LVIII (November-December, 1970), 612-617.

130. ________. "In Defense of Science," Science, CLXVII (January 9, 1970), 141-145.

131. Wolfle, Dael. "The Royal Science," Science Journal, IV (March, 1968), 80-84.

132. ________. "Science and Public Understanding," Science, CXXV (February 1, 1957), 179-182.

133. Working, Holbrook. "Research in the Social Sciences," Science, CIV (August 30, 1946), 193-197.

134. Wylie, Philip. "A Layman Looks at Biology," AIBS Bulletin (BioScience), IX (June, 1959), 12-15.

135. Ziman, John M. "Information, Communication, Knowledge," Nature, CCXXIV (October 25, 1969), 318-324.

General References: Books

136. Allen Francis, Hornell Hart, Delbert C. Miller, William F. Ogburn, and Meyer F. Nimkoff. Technology and Social Change. New York: Appleton-Century-Crofts, 1957, 529.

137. American Foundation for Continuing Education. Science and Public Policy. Dobbs Ferry, New York: Oceana, 1970, 650.

138. Barber, Bernard. Science and the Social Order. Glencoe, Illinois: Free Press, 1952, 288.

139. Bernal, J. D. Science in History. Cambridge, Massachusetts: M. I. T. Press, 1971, 362.

140. Beveridge, William I. B. The Art of Scientific Investigation. Rev. Ed. New York: Norton, 1957, 171.

141. Bond, Floyd A., ed. Technological Change and Economic Growth. Ann Arbor: Graduate School of Business Administration, University of Michigan (Michigan Business Papers, Number 41), 1965, 59.

142. Brickman, William H. and Stanley Lehrer, eds. Automation, Education, and Human Values. New York: School and Society Books, Division of the Society for the Advancement of Education, 1966, 419.

143. Calder, Ritchie. Science in Our Lives. New York: New American Library, 1954, 192.

144. Caldin, Edward F. The Power and Limits of Science: A Philosophical Study. London: Chapman and Hall, 1949, 196.

145. Compton, Walter D., ed. The Interaction of Science and Technology. Urbana: University of Illinois Press, 1969, 137.

146. Cornelius, Benjamin A. Science, Technology, and Human Values. Columbia: University of Missouri Press, 1965, 296.

147. DeGrazia, Alfred, ed. The Velikovsky Affair: The Warfare of Science and Scientism. New Hyde Park, New York: University Books, 1966, 264.

148. Ellul, Jacques. The Technological Society. Trans by John Wilkinson. New York: Knopf, 1964, 449.

149. Encyclopedia Britannica Conference on the Technological Order, Santa Barbara, California, 1962. The Technological Order: Proceedings. Ed. by Carl F. Stover. Detroit: Wayne State University Press, 1963, 280.

150. Fischer, R. B. Science, Man and Society. Philadelphia: W. B. Saunders, 1971, 130.

151. Gardner, Martin. Fads and Fallacies in the Name of Science. New York: Dover, 1957, 363.

152. Gouldner, Alvin W. and Richard A. Peterson. Notes on Technology and the Moral Order. Indianapolis: Bobbs-Merrill, 1962, 96.

153. Hildebrand, Joel H. Science in the Making. New York: Columbia University Press, 1957, 116.

154. Illinois Institute of Technology Research Institute. Technology in Retrospect and Critical Events in Science. Vol. I. Under Contract NSF-C535, for the National Science Foundation, December 15, 1968, 104.

155. Johnson, Martin C. Science and the Meaning of Truth. London: Faber and Faber, 1946, 179.

156. Jünger, Friedrich G. The Failure of Technology. Trans. from German. Chicago: Henry Regnery, 1956, 204.

157. Kaiser, Charles H. An Essay on Method. New Brunswick, New Jersey: Rutgers University Press, 1952, 163.

158. Kantor, Jacob R. The Logic of Modern Science. Bloomington, Indiana: Principia Press, 1953, 359.

159. Kuhn, Thomas S. The Structure of Scientific Revolutions. Chicago: University of Chicago Press, 1962, 172.

160. Lachman, Sheldon J. The Foundations of Science. Detroit: Hamilton Press, 1956, 130.

161. Medawar, Peter B. The Art of the Soluble. London: Methuen, 1967, 160.

162. Meier, Richard L. Science and Economic Development: New Patterns of Living. Cambridge, Massachusetts: M. I. T. Press, 1956, 266.

163. Nagel, Ernest. The Structure of Science: Problems in the Logic of Scientific Explanation. New York: Harcourt, Brace, and World, 1961, 618.

164. Nash, Leonard K. The Nature of the Natural Sciences. Boston: Little, Brown, 1963, 406.

165. Needham, Joseph. The Grand Titration: Science and Society in East and West. London: Allen and Unwin, 1969, 350.

166. Pantin, Carl F. A. The Relations between the Sciences. London: Cambridge University Press, 1968, 206.

167. Platt, John R. The Step to Man. New York: Wiley, 1966, 216.

168. Pokrovsky, Major Gen. G. I. Science and Technology in Contemporary War. Translated by Raymond L. Garthoff. New York: Praeger, 1959, 180.

169. Rapport, Samuel and Helen Wright. Science: Method and Meaning. New York: Washington Square Press, 1963, 248.

170. Reiser, Oliver L. The Integration of Human Knowledge: A Study of the Formal Foundations and the Social Implications of Unified Science. Boston: Porter Sargent, 1958, 478.

171. Rickert, Heinrich. Science and History: A Critique of Positivist Epistemology. Translated by George Reisman. Ed. by Arthur Goddard. Princeton, New Jersey: Van Nostrand, 1962, 161.

172. Schon, Donald A. Technology and Change. New York: Dell, 1967, 248.

173. Spicer, Edward H., ed. Human Problems in Technological Change: A Case Book. New York: Russell Sage Foundation, 1952, 301.

174. Standen, Anthony. Science Is a Sacred Cow. New York: Dutton, 1950, 221. (New edition 1959).

175. Toulmin, Stephen E. Foresight and Understanding: An Inquiry into the Aims of Science. Bloomington: Indiana University Press, 1961, 115.

176. ________. The Philosophy of Science: An Introduction. New York: Harper, 1960, 176.

177. Walker, Charles R., assisted by Adelaide G. Walker. Modern Technology and Civilization: An Introduction to Human Problems in the Machine Age. New York: McGraw-Hill, 1962, 469.

178. Walker, Marshall J. The Nature of Scientific Thought. Englewood Cliffs, New Jersey: Prentice-Hall, 1963, 184.

179. Ziman, John M. Public Knowledge: The Social Dimension of Science. London: Cambridge University Press, 1968, 154.

LEADING QUESTIONS

1. What is the meaning of "the scientific method"? What criteria are used, and by whom, to determine what methods are "scientific"?

2. Is advanced technology synonymous with "applied science" or are there differences between these terms? If differences, what are their implications?

3. What are some of the more important instances of the dependence of "pure" science upon technological innovation? (For example, in astronomy, physics, neurology, and microbiology.)

4. Do you agree that the interaction between science and technology is more the exception than the rule, and that the achievements of the last two centuries owe more to the advance of technology than to the progress of science?

5. Under present and prospective conditions of societies with highly developed technology, is there justification or utility in an intellectual attitude that separates scientific discovery from technological application? Should the two processes be viewed as a single continuum, or as interacting variables?

6. What is meant by the "science of science"; by the "sociology of science"; by the "political science of science"? How do they differ from the study of the "history and philosophy of science"? How does each of these fields differ from the study of "science, technology, and public policy"?

7. If you could reorganize a university upon the basis of the present state of knowledge would you change the present formal organization of the sciences and technical studies? If so, upon what basis or criteria would you act?

8. What are some of the more common popular misconceptions of science and technology? Why may these misconceptions prove to be socially harmful?

9. Is the "mystique of science" solely a consequence of unsophisticated popular attitudes? Has it been cultivated or resisted by scientists?

10. Stephen Toulmin writes: "Our lives are changed by its (science's) handiwork, but the population of the West is as far from understanding the nature of the strange power as a remote peasant of the Middle Ages may have been from understanding the theology of Thomas Aquinas." Do you agree?

TOPIC 02. SCIENCE AS AN ASPECT OF MODERN CULTURE

Every major aspect of modern culture or technology has been influenced by science; the perceptions, assumptions, themes, and techniques of the arts and humanities have been profoundly affected. Science may be said to have created a universal culture of its own--the technoscientific superculture--which overlays traditional societies and to which individuals, regardless of particular nationality, may equally belong as common members.

There is, nevertheless, in all modern nations a substratum of pre-scientific and unscientific attitude and belief that greatly complicates the shaping of public policy for science and technology. Nonscientific attitudes tend to be strongest in domestic, political, and religious affairs. Where strongly held, nonscientific values conflict with scientific judgment (as with family planning and population control), the task of public policy formulation is complicated.

Unlike traditional cultures, that may relate to all aspects of an individual's existence, the technoscientific superculture is incomplete. There are many aspects of life to which science and technology contribute only indirectly or not at all. No person can live wholly in the technoscientific superculture. The greater number of people in the world as yet live almost wholly in traditional or at least in nonscientific cultures. But persons who belong to the superculture of science and technology live in two cultures--the one in which they were born and reared, and the one in which they work as scientists, engineers, or physicians, with attitudes and techniques shaped through advanced technoscientific education. Where these two cultures are inconsistent with one another and are contradictory, conflict between and within groups and individuals arises. A notable instance of this conflict has been described by C. P. Snow in The Two Cultures.

Although it is possible to distinguish technoscientific culture from traditional culture, they are not manifest as clear-cut distinctions in most individuals. In any individual there may be a complex mixture of traditional attitudes and behavior patterns with beliefs and methods attributable to science. Modern science is, indeed, an outgrowth of historical Western civilization and in one sense is more truly an advanced phase of this traditional culture than an alien overlay. In this advance, however, the ties of modern science to historical Western culture have become increasingly attenuated, and in non-Western societies to which it is alien, science has often been a disruptive force. The wise use of science and its reconciliation with elements of traditional culture have now become challenges to the integrity of all human societies. Thus public policy for science is linked to social policy generally, and requires a high level of synthesis in conceptualizing and planning for society's future.

TOPIC 02 SCIENCE AS AN ASPECT OF MODERN CULTURE

Selected Basic Readings:

Ashmore, Jerome. "Some Reflections on Science and the Humanities," Physics Today, XVI (November, 1963), 46-54.

Boulding, Kenneth E. "The Scientific Revelation," Bulletin of the Atomic Scientists, XXVI (September, 1970), 13-18.

Dubos, René. "Science and Man's Nature," in Science and Culture: A Study of Cohesive and Disjunctive Forces, ed. by Gerald J. Holton. Boston: Houghton Mifflin, 1965, 251-272.

Holub, Miroslav. "Science in the Unity of Culture," Impact of Science on Society, XX (April-June, 1970), 151-158.

Toulmin, Stephen E. "The Evolutionary Development of Natural Science," American Scientist, LV (December, 1967), 456-471.

Supplementary and Substitute Readings:

Bronowski, Jacob. "Science as a Humanistic Discipline," Bulletin of the Atomic Scientists, XXV (April, 1969), 27-30.

Brooks, Harvey. "Scientific Concepts and Cultural Change," in Science and Culture: A Study of Cohesive and Disjunctive Forces, ed. by Gerald J. Holton. Boston: Houghton Mifflin, 1965, 70-87.

Gillispie, Charles C. "Remarks on Social Selection as a Factor in the Progressivism of Science," American Scientist, LVI (Winter, 1968), 439-450.

Snow, Charles P. The Two Cultures: And a Second Look. New York: Cambridge University Press, 1963, 107.

Stegeman, Beatrice. "Science as Art," Bulletin of the Atomic Scientists, XXIV (October, 1968), 33-38.

TOPICAL OUTLINE	REFERENCE KEY
I. Science as an Aspect of Western Civilization	59, 83
A. Historical and philosophical roots of modern science in ancient Greece and Rome Scientific thought a distinguishing characterisfic of Western civilization?	28, 43, 67, 88
1. "Scientific" epistemology: a dual process of arriving at and judging knowledge. Application of such criteria, e.g., by Artistotle, to the totality of human knowledge	21, 84
2. The concept of action, by the individual or the society, as ruled by reason, i.e., denial of tradition or authority as the necessary guides to action. Consequences in ethics, law, science, and technology-	82, 85, 86
3. The concept of man and the universe as "transparent" to the knowledge-seeker--epistemological optimism versus epistemological pessimism	48, 96
4. Concepts of the value of knowledge for its own sake	74
B. Development of intimate connections between science and technology (Review concepts developed in Topic 01)	38, 42
1. Ancient and oriental views	
a. Little or no connection between science and technology	28
b. Early links of scientific thought with religion, mysticism, medicine	87, 88
2. Three current views	
a. Classical: emphasizes the pursuit of knowledge for its intellectual and entertainment values. The "pure science" argument: science can progress best by following its own inner directions	1

b. Practical or Baconian: while admitting its intellectual values, science can be methodically directed toward goals having social value, toward technology — 52

c. Technological: science is or should be related to the unfolding of technological evolution which, in the long run, is self-augmenting; the direction of scientific progress is shaped by technological as well as by historical and economic forces — 67

3. Contrast and change: importation of modern concepts of science, via technology, into semi- or non-Western cultures (See Topics 07, 09, 10) — 4, 40, 44

H. Pervasive Influences of Scientific Concepts on Man's Images of Himself and the World (See also Topics 03, 16, and 30) — 27, 58

A. The increasing status of "scientific knowledge" in a technoscientific culture, as contrasted with mysticism, revelation, and conventional wisdom — 3, 10, 23

1. Historical relationships to the diminishing hold of traditional philosophical and religious beliefs — 47, 72

a. The destruction of the comprehensive Aristotelian system by such influences as the new astronomy of Copernicus and Galileo — 9, 88

b. Beginning of the age of epistemological optimism seen in the work of Descartes, Newton, and others—reaching its height in the 19th century — 13, 47, 73

c. The new geology of Lyell and the evolutionary biology of Darwin placed the history of life on earth, and man himself, in new perspectives — 17, 76, 77

2. Extensions (sometimes naive) of scientific concepts into other areas of thought (See also Topics 16, 21, 29, and 30) — 16, 23, 50, 51, 66

a. The Copernican Revolution: a cosmological about-face — 9

b. Darwin's Theory of Evolution: man's place in nature; social Darwinism — 19

c. Pavlov's psychology: "brainwashing"; the control of society; concepts of human nature

d. The new physics deriving from Einstein's relativity, Planck's quantum theory, Heisenberg's uncertainty theory: attempts to extrapolate to the social sciences and the humanities — 32, 37

B. Identification of "modernity" with scientific and science-derived progress — 66

1. Impingement of scientific and science-derived concepts on the Western world-view — 17, 23, 54, 61

a. Development of the view of a historical, evolving, noncyclical world which is open to study by the methodology of science

b. Growing identification of scientific thought as the model for all kinds of investigation — 6

2. Historical linkages of the concepts of social and human progress with developing scientific thought (See Topic 25) — 24, 30, 31, 66, 73, 96

a. The utopian literature of progress typified by the writings of Bacon, Owen, and Wells relied heavily on the rationality of science and on the fruits of science-based technology — 58

b. The literature of the Enlightenment, which greatly influenced future developments in political structures, ethics, and religion, made appeals to scientific rationality and independence of thought

c. Numerous socioeconomic theories, e.g., Cameralism, Technocracy, Marxism, have relied on technoscientific ingredients in the social systems proposed — 64, 65, 67

3. Factors aiding in the reinforcement of the connection of scientific with social progress — 46, 65, 86, 88
   a. Continuing success of the scientific method as a tool for increasing knowledge of the physical world
   b. The demonstrated power of science as a generator of technology
   c. The power of science-derived technology as an agent of social change (See Topic 03) — 29,34

III. Emergence of a Universal Technoscientific Culture — 8, 57, 65, 72, 80, 90

A. Cultural self-consciousness and cultural conflict in modern society — 3, 5
   1. Science and technology create awareness of cultural differences and cultural relativism — 17
   2. Culture becomes a tool of politics, e.g., German Kulturkampf, Pan-Slavism, Americanism — 75

B. Emergence of a distinctively technoscientific aspect or "layer" of Western culture, 1860-1960 — 9, 25, 52, 79, 85
   1. Growth of technoscientific occupations
   2. Increasing prominence of science in universities, displacing classics, humanities, and theology — 20, 66
   3. Transmission of technoscientific culture to non-Western world, via religious missionaries, business enterprise, military action, and philanthropic, educational, and technical assistance — 4, 43, 44
   4. Growth of an international technoscientific intelligentsia, partially detached from traditional cultures — 5

C. The "Two Cultures" conflict (See also Topic 05) — 14, 55, 60, 63, 91, 92

1. C.P. Snow's thesis--the English aspect of the general issue — 18, 49, 56, 71
2. Extent of separability of scientific from Western culture — 3, 5, 37, 62, 90
3. The complementary aspects of science and the humanities — 9, 11, 22, 95
4. Bridging the "scientist-humanist gap". — 12, 27, 41
5. Is a "third" culture really feasible? — 2, 39, 61
   a. Would its base be traditional or scientific?
   b. To what extent do we have evidence of the ability of existing traditional cultures to find an accomodation with science? — 53, 66, 70, 73
6. Is a single universal culture the possible outcome of technoscientific influence? Would such a culture be beneficial, harmful, preventable, or self-renewable? (See Topics 20, 25, and 30) — 35, 36

BIBLIOGRAPHY

General References: Articles

1. Appleton, Edward. "Science for Its Own Sake," Advancement of Science, X (September, 1953), 103-112.

2. Ashmore, Jerome. "Some Reflections on Science and the Humanities," Physics Today, XVI (November, 1968), 46-54.

3. Barber, Bernard. "Tensions and Accommodations between Science and Humanism," American Behavioral Scientist, VII (November, 1963), 3-8.

4. Basalla, George. "The Spread of Western Science," Science, CLVI (May 5, 1967), 611-622.

5. Bernard, Jessie. "Can Science Transcend Culture?" Scientific Monthly, LXXI (October, 1950), 268-273.

6. Blackman, Allan. "Scientism and Planning," American Behavioral Scientist, X (September, 1966), 24-28.

7. Boulding, Kenneth E. "The Diminishing Returns of Science," New Scientist and Science Journal, XLIX (March 25, 1971), 682-684.

8. ________. "The Scientific Revelation," Bulletin of the Atomic Scientists, XXVI (September, 1970), 13-18.

9. Bronowski, Jacob. "Science as a Humanistic Discipline," Bulletin of the Atomic Scientists, XXV (April, 1969), 27-30.

10. Brooks, Harvey. "Scientific Concepts and Cultural Change," in Science and Culture: A Study of Cohesive and Disjunctive Forces, ed. by Gerald J. Holton. Boston: Houghton Mifflin, 1965, 70-87.

11. Cassidy, Harold G. "The Muse and the Axiom," American Scientist, LI (September, 1963), 315-326.

12. ________. "The Problem of the Sciences and the Humanities: A Diagnosis and a Prescription," American Scientist, XLVIII (September, 1960), 383-398.

13. Crombie, A. C. "Historians and the Scientific Revolution," Endeavour, XIX (January, 1960), 9-13.

14. Crowe, Beryl L. "The Tragedy of the Commons Revisited," Science, CLXVI (November 28, 1969), 1103-1107.

15. Cummings, Sherwood. "Science in Fiction and Belles-Letters," in The Challenge of Science Education, ed. by Joseph S. Roucek. New York: Philosophical Library, 1959, 411-423.

16. Daniels, George H. "The Pure-Science Ideal and Democratic Culture," Science, CLVI (June 30, 1967), 1699-1705.

17. Dubos, René. "Science and Man's Nature," in Science and Culture: A Study of Cohesive and Disjunctive Forces, ed. by Gerald J. Holton. Boston: Houghton Mifflin, 1965, 251-272.

18. Eisley, Loren. "Illusion of Two Cultures," American Scholar, XXXIII (Summer, 1964), 387-399.

19. Ellegard, Alvar. "Darwinian Theory and Nineteenth-Century Philosophies of Science," Journal of the History of Ideas, XVIII (June, 1957), 362-393.

20. Farrington, Benjamin. "Science and the Classics," Nature, CXCI (September 30, 1961), 1337-1342.

21. Feigl, Herbert. "The Scientific Outlook: Naturalism and Humanism," in Readings in the Philosophy of Science, ed. by Herbert Feigl and May Brodbeck. New York: Appleton-Century-Crofts, 1953, 8-18.

22. Fleck, Alexander. "Science and the Humanities: Their Basic Unity," New Scientist, I (January 24, 1957), 10-12.

23. Frank, Philipp. "Contemporary Science and the Contemporary World View," in Science and Culture: A Study of Cohesive and Disjunctive Forces, ed. by Gerald J. Holton. Boston: Houghton Mifflin, 1965, 53-62.

24. Gillispie, Charles C. "Remarks on Social Selection as a Factor in the Progressivism of Science," AmericanScientist, LVI (Winter, 1968), 439-450.

25. Gould, Lawrence M. "Science and the Culture of Our Times," UNESCO Courier, XXI (February, 1968), 4-10.

26. Graubard, Mark. "The Frankenstein Syndrome: Man's Ambivalent Attitude to Knowledge and Power," Perspectives in Biology and Medicine, X (Spring, 1967), 419-443.

27. Gray, James. "The Proper Study of Mankind Is Man," Advancement of Science, XVI (September, 1959), 3-12.

28. Hacker, Barton C. "Greek Catapults and Catapult Technology: Science, Technology, and War in the Ancient World," Technology and Culture, IX (January, 1968), 34-50.

29. Hafstad, Lawrence R. "Science, Technology, and Society," American Scientist, XLV (March, 1957), 157-168.

30. Handlin, Oscar. "Science and Technology in Popular Culture," in Science and Culture: A Study of Cohesive and Disjunctive Forces, ed. by Gerald J. Holton. Boston: Houghton Mifflin, 1965, 184-198.

31. Harris, Britton. "A Technology of Social Progress," American Behavioral Scientist, XI (July-August, 1968), 7-10.

32. Heisenberg, Werner. "The Representation of Nature in Contemporary Physics," Daedalus, LXXXVII (Summer, 1958), 95-108.

33. Herschel, John. "The Influence of Science on the Well-Being and Progress of Society," in his Discourse on the Study of Natural Philosophy. London: Longman, Rees, Orme, Brown, and Greene, 1831.

34. Hoagland, Hudson. "Science and the New Humanism," Science, CXLII (January 10, 1964), 111-114.

35. Hogg, Quintin M. (Lord Hailsham). "Specific Present and Foreseeable Impacts of Science on Political Life," Nature, CCIII (July 11, 1964), 119-123.

36. Holub, Miroslav. "Science in the Unity of Culture," Impact of Science on Society, XX (April-June, 1970), 151-158.

37. Jaki, Stanley L. "The Role of Faith in Physics," Zygon, II (June, 1967), 187-202.

38. Jones, R. V. "Science, Technology, and Civilization," Nature, CXCIV (June 30, 1962), 1211-1214.

39. Levin, Harry. "Semantics of Culture," in Science and Culture: A Study of Cohesive and Disjuntive Forces, ed. by Gerald J. Holton. Boston: Houghton Mifflin, 1965, 1-13.

40. Malecki, I. "Some Problems Concerning Organization of Scientific Research in Developing Countries," Impact of Science on Society, XIII (Number 3, 1963), 181-200.

41. Mather, Kirtley F. "The Scientist's Responsibility for the Interpretation of Concepts to Laymen," Main Currents in Modern Thought, X (March, 1954), 81-83.

42. Multhauf, Robert P. "The Scientist and the 'Improver' of Technology," Technology and Culture, I (Winter, 1959), 38-47.

43. Needham, Joseph. "The Roles of Europe and China in the Evolution of Oecumenical Science," Advancement of Science, XXIV (September, 1967), 83-98.

44. ________. "Science and Society in East and West," Science and Society, XXVIII (Fall, 1964), 385-408.

45. Parrod, Jacques. "Chemistry and Society," Impact of Science on Society, XV (Number 2, 1965), 119-129.

46. Perrott, E. "Science as a Liberal Study," Advancement of Science, XXVII (March, 19[illegible]), 233-238.

47. Popper, Karl R. "Humanism and Reason," in his Conjectures and Refutations: The Growth of Scientific Knowledge. New York: Basic Books, 1962, 377-384.

48. ________. "On the Sources of Knowledge and of Ignorance," in his Conjectures and Refutations: The Growth of Scientific Knowledge. New York: Basic Books, 1962, 3-30.

49. Roberts, Catherine. "Nightingales, Hawks, and the Two Cultures," Antioch Review, XXV (Summer, 1965), 221-238.

50. Sargent, Frederick, II, and Demitri Shimkin. "Biology, Society, and Culture in Human Society," AIBS Bulletin (BioScience), XV (August, 1965), 512-516.

51. Sayre, Anne. "The Scientific Method in Human Affairs," Bulletin of the Atomic Scientists, XI (October, 1955), 295-296.

52. Seaborg, Glenn T. "Science and the Humanities: A New Level of Symbiosis," Science, CXLIV (June 5, 1964), 1199-1203.

53. ________. "A Scientific Society--The Beginnings," Science, CXXXV (February 16, 1962), 505-509.

54. Seitz, Frederick. "Science and Modern Man," American Scientist, LIV (September, 1966), 227-243.

55. Simon, Walter M. "The 'Two Cultures' in Nineteenth-Century France: Victor Cousin and Auguste Comte," Journal of the History of Ideas, XXVI (January-March, 1965), 45-58.

56. Stegeman, Beatrice. "Science as Art," Bulletin of the Atomic Scientists, XXIV (October, 1968), 33-38.

57. Stratton, Julius A. "Changing Role of Science and Technology," Nature, CCIII (August 1, 1964), 455-457.

58. Thomson, David. "Scientific Thought and Revolutionary Movements," Impact of Science on Society, VI (March, 1955), 3-29.

59. Toulmin, Stephen E. "The Evolutionary Development of Natural Science," American Scientist, LV (December, 1967), 456-471.

60. Walker, E. A. "A Call to Arms," Scientific Research, IV (March 31, 1969), 35-36.

61. Weil, Eric. "Science in Modern Culture," in Science and Culture: A Study of Cohesive and Disjunctive Forces, ed. by Gerald J. Holton. Boston: Houghton Mifflin, 1965, 199-217.

62. Whitehead, Alfred N. "Humanism in a Scientific Age," American Scientist, XLVI (September, 1958), 309-322.

63. Wolfle, Dael. "The Royal Science," Science Journal, IV (March, 1968), 80-84.

64. Zvorikine, A. A. "Technology and the Laws of Its Development," Technology and Culture, III (Fall, 1962), 433-458.

General References: Books

65. Barber, Bernard. Science and the Social Order. Glencoe, Illinois: Free Press, 1952, 288.

66. Barzun, Jacques, Science: The Glorious Entertainment. New York: Harper and Row, 1964, x, 322.

67. Bernal, John D. Science in History. New York: Hawthorn, 1965, 1039.

68. Boyko, Hugo. ed. Science and the Future of Mankind. Bloomington: Indiana University Press, 1964, viii, 380.

69. Bronowski, Jacob. Science and Human Values. Rev. Ed. New York: Harper and Row, 1965, 119.

70. Bush, Douglas. Science and English Poetry: A Historical Sketch, 1590-1950. New York: Oxford University Press, 1950, vii, 166.

71. Cornelius, David K. and Edwin St. Vincent. Cultures in Conflict: Perspectives on the Snow-Leavis Controversy. Chicago: Scott, Foreman, 1964, 179.

72. Cournand, A. F. and H. A. Zuckerman. The Code of Science: Analysis and Reflections on Its Future. New York: Institute for the Study of Science in Human Affairs, Columbia University, 1970, 43.

73. Dillenberger, John. Protestant Thought and Natural Science: A Historical Interpretation. London: Collins, 1961, 320.

74. Dubos, René. The Cultural Roots and the Social Fruits of Science. Eugene: University of Oregon Press, 1963, 38.

75. Gardner, Martin. Fads and Fallacies in the Name of Science. New York: Dover, 1957, x, 363.

76. Gillispie, Charles C. Genesis and Geology: The Impact of Scientific Discoveries upon Religious Beliefs in the Decades before Darwin. New York: Harper, 1959, xiv, 306.

77. Greene, John C. The Death of Adam: Evolution and Its Impact on Western Thought. Ames: Iowa State University Press, 1961, 141.

78. Habgood, John S. Religion and Science. Ed. by J. Goodier. London: Mills and Boon, 1964, viii, 159. Biblio.

79. Harrison, George R. The Role of Science in Our Modern World. New York: Morrow, 1956, 278.

80. Holton, Gerald J., ed. Science and Culture: A Study of Cohesive and Disjunctive Forces. Boston: Houghton Mifflin, 1965, xxxii, 348.

81. Kaplan, Norman, ed. Science and Society. Chicago: Rand McNally, 1965, ix, 595. Biblio.

82. King, James E. Science and Rationalism in the Government of Louis XIV. Baltimore: Johns Hopkins Press, 1949, 377.

83. Kranzberg, Melvin and Carroll W. Pursell, Jr., eds. Technology in Western Civilization. Vol. I: The Emergence of Modern Industrial Society, Earliest Times to 1900, xii, 802. Vol. II: Technology in the Twentieth Century, xii, 772. New York: Oxford University Press, 1967.

84. Kuhn, Thomas S. The Structure of Scientific Revolutions. Chicago: University of Chicago Press, 1962, xv, 172. Ch. X: "Revolutions as Changes of World View."

85. Lindsay, Robert B. The Role of Science in Civilization. New York: Harper and Row, 1963, 318.

86. Marsak, Leonard M., ed. The Rise of Science in Relation to Society. New York: Macmillan, 1964, ix, 150.

87. Pauwels, Louis and Jacques Bergier. The Morning of the Magicians. Trans. by Rollo Meyers. New York: Stein and Day, 1964, xii, 300.

88. Price, Derek J. de Solla. Science since Babylon. New Haven, Connecticut: Yale University Press, 1961, 149.

89. Prior, Moody. Science and the Humanities. Evanston, Illinois: Northwestern University Press, 1962, xii, 124.

90. Rabi, Isidor I. Science: The Center of Culture. New York: New American Library, 1970, 155.

91. Ross, Alan S. C., ed. Arts v. Science. New York: Barnes and Noble, 1970, 158.

92. Snow, Charles P. The Two Cultures: And a Second Look. New York: Cambridge University Press, 1963, 107.

93. Stauffer, Robert C., ed. Science and Civilization. Madison: University of Wisconsin Press, 1949, xiii, 212.

94. Vavoulis, Alexander and A. Wayne Colver, eds. Science and Society: Selected Essays. San Francisco: Holden-Day, 1966, v, 153.

95. Waddington, Conrad H. Behind Appearance: A Study of Relations between Painting and Natural Science in This Century. Cambridge, Massachusetts: M. I. T. Press, 1970, 256.

96. Westfall, Richard S. Science and Religion in Seventeenth Century England. New Haven, Connecticut: Yale University Press, 1958, ix, 235.

LEADING QUESTIONS

1. George Sarton once observed that the proper focus of history should be on the development of science and technology, rather than on diplomatic relations and wars between nations. To what extent was his view valid?

2. What is the "fit" of science in modern Western culture? Is it indeed an integral part of this culture? Has its relationship to traditional culture changed?

3. Can we explain some of the characteristic differences between past and present Western cultures as consequences of the roles played in the culture by science? If so, could we extend this analysis to other cultures?

4. What explanations have been advanced for the growth of scientific thought in the West, in contrast to its delayed or arrested development in China, India, the Islamic world, and Africa?

5. You may recall a conviction--common a few years ago--that science can only develop in a "free" society. How would you evaluate this view? What kinds of societies do you think would be favorable or unfavorable to science?

6. Jacques Barzun argues that science has taken up a role in this culture analogous in many ways to that of religion in medieval times. Does this analogy seem reasonable? In what ways might it be misleading?

7. Is there evidence that the amount of superstition in society (beliefs in things that are not so) has remained relatively constant throughout historic time, and that science has merely changed the things about which people are superstitious? Would the G.N.P. as indicator of economic health be a superstition?

8. Do the following statements illustrate "scientism"? (a) science is the likely source of technological answers to all the problems of society; (b) science is the model for all types of investigation or problem-solving. Are these views reasonable, or should they be qualified or denied?

9. Science in the abstract has sometimes been described as anti-cultural. Why? How does this view of science relate to the "two cultures" controversy?

10. What significance do the following terms have in relation to science?
    - a. Planned Parenthood
    - b. Psychoanalysis
    - c. Relativism
    - d. Technocracy
    - e. Human Engineering
    - f. Christian Science

TOPIC 03 SOCIAL IMPACT OF SCIENCE AND TECHNOLOGY

Until the 19th century, the impact of science on society was largely distinguishable from the impact of technology. Since prehistoric time, technology rather than science has shaped man's behavior and his institutions. Technological innovation, as illustrated by such events as the beginning of agriculture, the discovery of the wheel, and the working of metals, has repeatedly revolutionized social conditions. But throughout most of historic time the influence of science has been confined to the beliefs of small numbers of highly literate or inquisitive individuals, and its effects have been slow and accumulative.

During the latter half of the 19th century, scientific discovery and technological innovation increasingly became interdependent. Since 1900, it has become difficult to distinguish precisely between scientific and technological forces for social change. The revolutionary developments of the present era, in atomic energy, in communications, in medicine, in automation, are technoscientific. They are applications of advanced scientific thought and sophisticated technologies. Although their impact upon society may or may not be as decisive as those earliest technological innovations that enabled man to pass from prehistory into historic times, their combined power to change institutions, beliefs, and practices is very great.

In the technoscientific society of the 20th century, technology appears to dominate science.. Explanation lies in the direct applicability of technology to practical affairs. Technology directly serves economic, military, and civic purposes. Science informs the mind, but usually must be translated into technology before it can change the external characteristics of society.

The influence of technology on society has been the subject of an extensive and critical literature. A major theme is the automatic and self-augmenting character of technology; dealt with most explicitly in The Technological Society by the French sociologist, Jacques Ellul. The inevitability of technological development under favorable conditions is widely accepted and vigorously disputed. The issue is the extent to which societies of men can control and direct their scientific and technological development. A strong trend toward technoscientific determinism characterizes contemporary thinking and is especially prominent in technological forecasting and in science fiction.

But reaction against the doctrine of technoscientific inevitability has been growing, especially in advanced industrial societies. In its more constructive phase this movement is toward a more selective use of science and technology to shape a desired future instead of acquiescing in a future shaped by their uncritical applications.

TOPIC 03 SOCIAL IMPACT OF SCIENCE AND TECHNOLOGY

Selected Basic Readings:

Branscomb, Lewis M. "Taming Technology," Science CLXXI (March 12, 1971), 972-977.

Brooks, Harvey. "Can Science Survive in the Modern Age?" Science, CLXXIV (October 1, 1971), 21-30.

Carroll, James D. "Participatory Technology," Science, CLXXI (February 19, 1971), 647-658.

Mesthene, Emmanuel G. "How Technology Will Shape the Future," Science, CLXI (July 12, 1968), 135-143.

Weinberg, Alvin M. "In Defense of Science," Science, CLXVII (January 9, 1970), 141-145.

Supplementary and Substitute Readings:

Daddario, Emilio Q. "Technology and the Democratic Process," Technology Review, LXXIII (July-August, 1971), 18-23.

DuBridge, Lee A. "The Social Control of Science," Bulletin of the Atomic Scientists, XXV (May, 1969), 26-28; 35.

Ellul, Jacques. "Technique, Institutions, and Awareness," American Behavioral Scientist, XI (July-August, 1968), 38-42.

Glass, H. Bentley. "Science: Endless Horizons or Golden Age?" Science, CLXXI (January 8, 1971), 23-29.

Hugh-Jones, Edward M. "The Impact of Technological Change," Advancement of Science, XXV (September, 1968), 23-29.

Wolff, Harold. "The Impact of Society on Science," American Behavioral Scientist, X (May, 1967), 2-7.

TOPICAL OUTLINE	REFERENCE KEY
I. Distinctions between the Effects of Science and Technology, and Their Significance	16, 173, 182
A. Common effects	8
1. Initial effects not necessarily same as ultimate effects	99, 182
a. Darwinian evolution	
b. Internal combustion engine	
c. Antibiotics in tropical countries	
d. Outer-space exploration	134, 178
2. Individual effects not always predictive of synergistic effects	16, 139
3. Technoscientific innovations frequently incur unforeseen effects owing to:	23, 44, 78, 138, 139
a. Preoccupation of innovators with the target to the neglect of side effects	28
b. Lack of adequate testing and analysis of possible consequences (Cf. Topic 13)	
4. Influence of science and technology may be changed as readily by emergent forces in the environment (e. g., competing forces, theories, or technologies) as by intrinsic properties of scientific ideas or techniques themselves	173
B. Differences in the effects of science and technology	
1. Science tends initially to affect the mind, e.g., attitudes, beliefs, perceptions of people; and afterward indirectly to influence their behavior. Examples: Freudian psychology: psychiatry; Mendelian genetics: plant breeding	37

2. Technology tends initially to influence behavior, and later indirectly to affect the explanations for the behavior through theory	12, 34, 162, 76, 87, 139
a. Birth control devices: "new morality"	8
b. Television: "the medium is the message"	34, 157
II. Emergence of a Technoscientific Society	5, 81, 82, 137, 142, 155, 157, 176
A. Conditions conducive to the dominance of technique in society (after J. Ellul)	32, 43, 86, 118, 155, 167
1. Facilities for communication and transportation	153
2. Widespread literacy and information	127
3. Development of artisan or mechanic skills	
4. Economic margin beyond subsistence	
5. Concentrations of wealth and population	127
6. Innovative or entreprenurial motivation	
7. Growth of a middle class	
8. Breakdown of social barriers and communal integrity	
9. Social and intellectual fluidity	
10. Complex organizational techniques	
11. Tolerance for complexity and uncertainty	
12. Cooperation for non-personal ends	136
13. Freedom of inquiry	89, 116, 127
B. The emergence of the technoscientific society as a phenomenon of "critical mass" or chain reaction	155
1. Ellul's concept of "technological"	
a. Automatism	
b. Self-augmentation	
c. Monism	
d. Technical universalism	
2. Technology as an aspect of the explosion of knowledge and a factor in the emergence of a world society	58
3. Factors affecting the transfer of technology (Cf. Topic 13)	

C.	Effects of accelerated and unbalanced technological change	57, 114, 115, 153, 155, 180, 182
	1. "Unbalance" or "imbalance" in technology and normative concepts	173
	a. Fact of imbalance does not necessarily imply adverse effects	
	b. Imbalance sometimes sought as a change agent, especially in developing countries (cf. Topic 10)	158
	c. Political institutions need to be restructured to cope with technological change	32, 52, 151
	2. Adverse effects of technological imbalance are frequently	42, 145, 164, 173
	a. Environmental	41, 49, 54, 78, 150, 154
	b. Esthetic	56, 182
	c. Psychological	103, 131, 182
	d. Economic	27, 44, 56, 163
	3. Possibility of leveling-off of scientific growth	40, 124
III.	Implications of Technoscience for Society	15, 16, 29, 77, 79, 83, 125, 126, 128, 160, 166, 174, 176, 181
A.	Social trends induced by technoscience	39, 45, 72, 119
	1. Power, wealth, and knowledge tend to become inter-convertible	60, 107, 150, 172
	2. Physical means for communication increase, but specialization complicates mutual understanding	53, 149, 159
	3. Acceleration of the growth of knowledge:	169, 183
	a. Increases obsolescence of knowledge and skill	
	b. Enlarges the frontiers of ignorance	
	c. Necessitates continuing reeducation	
	4. Distribution of knowledge becomes more specialized and uneven, necessitating cooperative or systems approach to problem solving	4, 120

5. Through government and research, means are sought to cope with the social instabilities induced by technoscientific change	
a. Compensation for technological displacement of workers	27, 44
b. Technological forecasting to prepare for technological change (cf. Topic 13)	18, 59, 62, 66, 99, 113, 133
c. Biotechnology and human engineering to accommodate technology to man and man to technology	2, 68, 160, 179, 184
B. Requisites for control of science and technology in behalf of human welfare	10, 30, 71, 75, 85, 93, 101, 106, 133, 135, 148, 173
1. High level of public rationality	17, 108,
2. Increase in scientific literacy	132
3. More effective syntheses of knowledge	171, 177
4. Lifetime duration of education and training	177
5. Improved system for making policy choices	36, 66, 69, 91, 96, 102, 109
6. Clarification of ethical guidelines consistent with scientific knowledge	145, 151
7. Means of assessing and forecasting the effects of technological change (cf. Topic 13)	38, 61, 79, 135
C. Reasons for increasing disenchantment of the public with science and technology	3, 7, 9, 20, 26, 63, 70, 73, 80, 90, 100, 105, 110, 111, 121, 155, 156
1. Development of powerful nuclear, biological, and chemical weapons based on the latest science and technology	13
2. Apparent inability to solve social problems such as the plight of the cities, crime, and the use of hard drugs	21, 51, 67
3. Pollution of the environment seen as a necessary result of the use of technology	74, 95, 154
4. Feeling that the benefits of science and and technology have not been commensurate with the vast sums spent on them in the last two decades	98, 130

BIBLIOGRAPHY

General References: Articles

1. American Association for the Advancement of Science, Committee on Science in the Promotion of Human Welfare. "The Integrity of Science," American Scientist, LIII (June, 1965), 174-198.

2. Arthur, Robert M. "Bioengineering: A Definition," AIBS Bulletin (BioScience), XIV (October, 1964), 29-30.

3. Ashby, Eric. "Science and Antiscience," Nature, CCXXX (April 2, 1971), 283-286.

4. Beard, Charles A. "Government by Technologists," New Republic, LXIII (June 18, 1930), 115-120.

5. Ben-David, Joseph. "Scientific Growth: A Sociological View," Minerva, II (Summer, 1964), 455-476.

6. ________. "The Scientific Role: The Conditions of Its Establishment in Europe," Minerva, IV (Autumn, 1965), 15-54.

7. Bereano, Philip L. "The Scientific Community and the Crisis of Belief," American Scientist, LVII (Winter, 1969), 484-501.

8. Bernard, Jessie. "Technology, Science, and Sex Attitudes," Impact of Science on Society, XVIII (October-December, 1968), 213-228.

9. Branscomb, Lewis M. "Physics and the Nation in a Crystal Ball," Physics Today, XXI (August, 1968), 23-28.

10. ________. "Taming Technology," Science, CLXXI (March 12, 1971), 972-977.

11. Briggs, Asa. "Technology and Scientific Development," Scientific American, CCIX (September, 1963), 52-61.

12. Bronowski, Jacob. "What We Can't Know," Saturday Review, LII (July 5, 1969), 44-45.

13. Brooks, Harvey. "Can Science Survive in the Modern Age?" Science, CLXXIV (October 1, 1971), 21-30.

14. ______. "Physics and the Polity," Science, CLX (April 26, 1968), 396-400.

15. Burlingame, Robert. "Technology: Neglected Clue to Historical Change," Technology and Culture, II (Summer, 1961), 219-229.

16. Burns, Tom. "The S[illegible] Character of Technology," Impact of Science on Society, VII (September, 1956), 147-165.

17. Carroll, James D. "Participatory Technology," Science, CLXXI (February 19, 1971), 647-658.

18. Cetron, Marvin J. "Forecasting Technology," International Science and Technology, Number 69 (September, 1967), 83-92.

19. Chase, Edward J. "Politics and Technology," Yale Review, LII (March 1963), 321-339.

20. Chedd, G. "Scientific Counter Culture," New Scientist and Science Journal, XLIX (January 28, 1971), 174-176.

21. Cohn, Victor. "Who Needs Science? See Your Congressman," Technology Review, LXXII (December, 1969), 8-9.

22. Conant, James B. "The Impact of Science on Industry and Medicine," American Scientist, XXXIX (January, 1951), 33-49.

23. Cottrell, W. Fred. "Death by Dieselization: A Case Study in the Reaction to Technological Change," American Sociological Review, XVI (June, 1951), 358-365.

24. Daddario, Emilio Q. "Technology and the Democratic Process," Technology Review, LXXIII (July-August, 1971), 18-23.

25. Dechert, Charles R. "The Development of Cybernetics," American Behavioral Scientist, VIII (June, 1965), 15-20.

26. Dedijer, Stevan. "The R & D Depression in the United States," Science, CLXVIII (April 17, 1970), 344-345.

27. Diebold, John. "Automation: Perceiving the Magnitude of the Problem," Cybernetica, VIII (Number 3, 1965), 150-156.

28. Drucker, Peter F. "The First Technological Revolution and Its Lessons," Technology and Culture, VII (Spring, 1966), 143-151.

29. DuBridge, Lee A. "Science Serves Society," Science, CLXIV (June 6, 1969), 1137-1140.

30. ______. "The Social Control of Science," Bulletin of the Atomic Scientists, XXV (May, 1969), 26-28; 35.

31. Edwards, A. W. F. "Science, Statistics, and Society," Nature, CCXXXIII (September 3, 1971), 17-19.

32. Ellul, Jacques. "Technique, Institutions, and Awareness," American Behavioral Scientist, XI (July-August, 1968), 38-42.

33. Etzioni, Amitai. "Sex Control, Science, and Society," Science, CLXI (September 13, 1968), 1107-1112.

34. Ezratty, Sacha. "Films and Society," Impact of Science on Society, XIII (Number 2, 1963), 147-169.

35. Falk, John and Marjory O'Dea. "Science, Technology, and Society: An Outline of the Development of Scienomics," Australian Quarterly, XXXIX (December, 1967), 50-65.

36. Ferry, Wilbur H. "Must We Rewrite the Constitution to Control Technology," Saturday Review, LI (March 2, 1968), 50-54.

37. Fraccaro, Marco. "The Implications of Genetics for Procreation and Marriage," Impact of Science on Society, XVIII (October-December, 1968), 259-271.

38. Gabor, Dennis. "Technological Forecasting in a Social Frame," SSF Newsletter, III (August, 1968), 9-18.

39. Gerber, William. "Science and Society," Editorial Research Reports (October 15, 1969), 773-792.

40. Glass, H. Bentley. "Science: Endless Horizons or Golden Age?" Science, CLXXI (January 8, 1971), 23-29.

41. Goldman, Marshall I. "The Convergence of Environmental Disruption," Science, CLXX (October 2, 1970), 37-42.

42. Goodman, Paul. "The Trouble with Today's Technology: A Social Critic's View," Innovation, II (June, 1969), 38-47.

43. Gordon, Theodore J. and A. L. Shef. "National Programs and the Progress of Technological Societies," Journal of the Astronautical Sciences, XV (September-October, 1968), 231-241.

44. Gordon, William E. "Economical and Social Effect of Automation: Prevailing Thought and Experience in the United States," Cybernetica, VII (Number 4, 1964), 262-284.

45. Grunbaum, Adolf. "Science and Man," Perspectives in Biology and Medicine, V (Summer, 1962), 483-502.

46. Gunn, Hartford N., Jr. "New Technology for Public Communications," Technology Review, LXXIII (July-August, 1971), 24-29.

47. Hall, George R. and Robert ~~E. Johnson~~. Transfers of United States Aerospace Technology to Japan. Santa Monica, California: RAND Corporation, 1968, 95.

48. Handlin, Oscar. "Science and Technology in Popular Culture," in Science and Culture, ed. by Gerald J Holton. Boston: Beacon Press, 1967, 184-198.

49. Hardin, Garrett. "To Trouble a Star: The Cost of Intervention in Nature," Bulletin of the Atomic Scientists, XXVI (January, 1970), 17-20.

50. Haring, Douglas G. "Science and Social Phenomena," American Scientist, XXXV (July, 1947), 349-363.

51. Hartner, Willy. ~~"The~~ Place of Humanism in a Technological World," Technology and Culture, III (Fall, 1962), 533-544.

52. Harvey, Edward. "Technology and the Structure of Organizations," American Sociological Review, XXXIII (April, 1968), 247-259.

53. Heidt, Sarajane. "Knowledge and Its Consequences: The Impact of Information on a Family Planning Program," American Behavioral Scientist, XII (November-December, 1968), 43-48.

54. Hillaby, John. "Higher Politics on Tortoise Island," New Scientist, XXXIV (June 9, 1967), 584-585.

55. Hollomon, J. Herbert. "Modern Engineering and Society: The Marriage between Technical Ability and Social Needs," Chemical and Engineering News, XLII (June 29, 1964), 66-71.

56. Hugh-Jones, Edward M. "The Impact of Technological Change," Advancement of Science, XXV (September, 1968), 23-29.

57. Iacono, Gustavo. "An Affiliative Society Facing Innovations," Journal of Social Issues, XXIV (April, 1968), 135-140.

58. Ihde, Aaron J. "The Inevitability of Scientific Discovery," Scientific Monthly, LXVII (December, 1948), 427-429.

59. Jantsch, Erich. "Technological Forecasting," OECD Observer, Number 27 (April, 1967), 33-34; 36.

60. Jouvenal, Bertrand de. "The Technocratic Age," Bulletin of the Atomic Scientists, XX (October, 1964), 27-29.

61. Kahn, Herman. "World Futures," Science Journal, III (October, 1967), 121-125.

62. Kahn, Herman and Anthony J. Wiener. "Faustian Powers and Human Choices: Some 21st-Century Technological and Economic Issues," in Environmental Change, The Next Fifty Years, ed. by William R. Ewald, Jr. Bloomington: Indiana University Press, 1968, 101-131.

63. Kantrowitz, Arthur. "The Test: Meeting the Challenge of New Technology," Bulletin of the Atomic Scientists, XXV (November, 1969), 20-24.

64. Kinzel, Augustus B. "Engineering, Civilization, and Society," Science, CLVI (June 9, 1967), 1343-1345.

65. Knoppers, Antonie T. "Transferring Technology: A New Situation," Interplay, II (November, 1968), 26-29.

66. La Porte, Todd R. "Politics and 'Inventing the Future': Perspectives in Science and Government," Public Administration Review, XXVII (June, 1967), 117-127.

67. Lasswell, Harold D. "Must Science Serve Political Power?" American Psychologist, XXV (February, 1970), 117-123.

68. Leaf, Alexander. "Social Consequences of New Developments in Medicine," Bulletin of the Atomic Scientists, XXVI (January, 1970), 21-22.

69. Lendvall, Frederick C. "Science and the Social Imperatives," American Scientist, LVI (Winter, 1968), 303-311.

70. Lessing, L. "The Senseless War on Science," Fortune, LXXXIII (March, 1971), 88-91; 153-155.

71. Liverman, J. L. "Making Science Serve Man," Congressional Record, CXVII (July 16, 1971), E7839-E7840.

72. Lonsdale, Kathleen. "Science and the Good Life," Advancement of Science, XXV (September, 1968), 1-11.

73. McElroy, W. D. "The Role of Fundamental Research in an Advanced Society," American Scientist, LIX (May-June, 1971), 294-297.

74. Maddox, J. "The Doomsday Syndrome," Nature, CCXXXIII (September 3, 1971), 15-16.

75. Martino, Joseph P. "Science and Society in Equilibrium," Science, CLXV (August 22, 1969), 769-772.

76. Meier, Richard L. "Violence: The Last Urban Epidemic," American Behavioral Scientist, XI (March-April, 1968), 35-37.

77. Mencher, Alan G. "On the Social Deployment of Science," Bulletin of the Atomic Scientists, XXVII (December, 1971), 34-38.

78. Mesthene, Emmanuel G. "How Technology Will Shape the Future," Science, CLXI (July 12, 1968), 135-143.

79. ________. "Our Threatened Planet: The Technological Plague," Science, CLV (January 27, [illegible]), 441-442.

80. Morison, Robert S. "Science and Social Attitudes," Science, CLXV (July 11, 1969), 150-156.

81. Mumford, Lewis. "History: Neglected Clue to Technological Change," Technology and Culture, II (Summer, 1961), 230-236.

82. ________. "Technics and the Nature of Man," Nature, CCVIII (December 4, 1965), 923-928.

83. Ogburn, William F. "How Technology Changes Society," Annals of the American Academy of Political and Social Science, CCXLIX (January, 1947), 81-88.

84. Piel, Gerard. "Human Want Is Obsolete," Saturday Review, XXXVI (June 27, 1953), 9-11; 25.

85. Pierce, John R. "Technology and Freedom," New Scientist, XXV (March 11, 1965), 650-651.

86. Polanyi, Michael. "The Growth of Science in Society," Minerva, V (Summer, 1967), 533-545.

87. Possony, Stefan T. "Technology and the Human Condition," American Behavioral Scientist, XI (July-August, 1968), 43-48.

88. Potter, Van Renssalaer. "Society and Science," Science, CXLVI (November 20, 1964), 1018-1022.

89. Preston, Frederick W. "Freedom of Research," Scientific Monthly, LXI (December, 1945), 477-482.

90. Price, Don K. "Purists and Politicians," Science, CLXIII (January 3, 1969), 25-31.

91. Quinn, James B. "National Strategy in Science and Technology," Science Journal, V (April, 1969), 77-81.

92. Rabi, Isidor I. "Technology: A Boon and a Danger," A.I.A. Journal, XLVI (September, 1966), 63-64.

93. Rabinowitch, Eugene. "Living Dangerously in the Age of Science," Bulletin of the Atomic Scientists, XXVIII (January, 1972), 5-8.

94. ________. "The Mounting Tide of Unreason," Bulletin of the Atomic Scientists, XXVII (May, 1971), 4-9.

95. Ravetz, J. "Ideological Crisis in Science," New Scientist and Science Journal, LI (July 1, 1971), 35-36.

96. Rickover, Hyman G. "A Humanistic Technology," Nature, CCVIII (November 20, 1965), 721-726.

97. Rivers, John P. W. "Technology and Literature," New Scientist, XXXV (August 17, 1967), 355-357.

98. Rose, Hilary. "Pangloss and the Jeremiah in Science," Nature, CCXXIX (February 12, 1971), 459-462.

99. Rose, Steven. "Forecasting the Impact of Science," New Scientist, XXXII (November 10, 1966), 288.

100. Roszak, T. "Autopsy on Science," New Scientist and Science Journal, XLIX (March 11, 1971), 536-538.

101. Ruina, J. P. "Can We Control the Goose That Is Laying the Golden Eggs?" Innovation, XVI (November, 1970), 36-41.

102. Sayre, Wallace S. and Bruce L. R. Smith. Government, Technology, and Social Problems. New York: Institute for the Study of Science in Human Affairs, Columbia University, 1969, 33.

103. Schon, Donald A. "The Fear of Innovation," International Science and Technology," Number 59 (November, 1966), 70-78.

104. Science Journal. "Science for Mankind," Science Journal, Va (October, 1969), entire issue.

105. Seaborg, Glenn T. "The New Optimism," Futurist, III (December, 1969), 157-160.

106. Seidman, A. "Barriers to Technical Innovation," Bulletin of the Atomic Scientists, XXVII (March 3, 1971), 29-31.

107. Seitz, Frederick. "Science and Modern Man," American Scientist, LIV (September, 1966), 227-243.

108. Shannon, James A. "Science and Social Purpose," Science, CLXIII (February 21, 1969), 769-773.

109. Sheridan, T. B. "Citizen Feedback: New Technology for Social Choice," Technology Review, LXXIII (January, 1971), 47-51.

110. Shils, Edward. "Anti-Science," Minerva, IX (October, 1971), 441-450.

111. ________. "Of Pride and Men of Little Faith," Minerva, IX (January, 1971), 1-6.

112. Silverman, William. "The Economic and Social Effects of Automation in an Organization," American Behavioral Scientist, IX (June, 1966), 3-8.

113. Sinsheimer, Robert. "The End of the Beginning," Bulletin of the Atomic Scientists, XXIII (February, 1967), 8-12.

114. Sklair, Leslie. "The Revolt Against the Machine: Some Twentieth Century Criticisms of Scientific Progress," Journal of World History, XII (1970), 479-489.

115. ________. "The Sociology of the Opposition to Science and Technology: With Special Reference to the Work of Jacques Ellul," Comparative Studies in Society and History, XIII (April, 1971), 217-235.

116. Smyth, Henry D. "The Place of Science in a Free Society," American Scientist, XXXVIII (July, 1950), 426-436.

117. Sonneborn, Tracy M. "Implications of the New Genetics for Biology and Man," AIBS Bulletin (BioScience), XIII (April, 1963), 22-26.

118. Spaey, J. "Conditions for Success in the Economic and Social Development of Nations through Science," OECD Observer, Number 33 (April, 1968), 32-34.

119. Spiro, Thomas. "Science and the Relevance of Relevance," Antioch Review, XXIX (Fall, 1969), 389-403.

120. Stover, Carl F. "Industry, Technology, and Metropolitan Problems," Public Administration Review, XXVII (June, 1967), 112-117.

121. Thackray, Arnold. "Reflections on the Decline of Science in America and on Some of Its Causes," Science, CLXXIII (July 2, 1971), 27-31.

122. Thring, M. W. "The Next Thirty Years in Engineering," Advancement of Science, XXIV (September, 1967), 99-106.

123. Topchiev, Alexander V. "Interdependence of Science and Society," Bulletin of the Atomic Scientists, XIX (March, 1963), 7; 9-11.

124. Toulmin, Stephen E. "Is There a Limit to Scientific Growth?" Science Journal, II (August, 1966), 80-85.

125. Tribus, Myron. "Technology and Society--The Real Issues," Bulletin of the Atomic Scientists, XXVII (December, 1971), 27-30.

126. ______. "Technology for Tomorrow vs. Profit for Today," Mechanical Engineering, XCIII (May, 1971), 16-19.

127. Weaver, Warren. "The Encouragement of Science," Scientific American, CXCIX, (September, 1958), 170-178.

128. Wedgewood Benn, Anthony. "Technical Power and People - The Impact of Technology on the Structure of Government," Bulletin of the Atomic Scientists, XXVII (December, 1971), 23-26.

129. Weinberg, Alvin M. "Can Technology Replace Social Engineering?" Bulletin of the Atomic Scientists, XXII (December, 1966), 4-8.

130. ______. "In Defense of Science," Science, CLXVII (January 9, 1970), 141-145.

131. Whitney, Vincent H. "Resistance to Innovation: The Case of Atomic Power," American Journal of Sociology, LVI (November, 1950), 247-254.

132. Wilson, J. Tuzo. "Science Is Everybody's Business," American Scientist, LII (September, 1964), 266A-276A.

133. Wohlstetter, Albert. "Technology, Prediction, and Disorder," Bulletin of the Atomic Scientists, XX (October, 1964), 11-15.

134. Wolff, Harold. "The Impact of Society on Science," American Behavioral Scientist, X (May, 1967), 2-7.

135. Wormuth, Francis D. "Government and Science," Center Magazine, III (March-April, 1970), 41-46.

136. Zilsel, Edgar. "The Genesis of the Concept of Scientific Progress," Journal of the History of Ideas, VI (June, 1945), 325-349.

General References: Books

137. Armytage, Walter H. G. The Rise of the Technocrats--A Social History. London: Routeledge and Kegon Paul, 1965, vii, 448.

138. Aron, Raymond, ed. World Technology and Human Destiny. Ann Arbor: University of Michigan Press, 1963, vi, 249.

139. Bauer, Raymond A., et al. Second-Order Consequences: A Methodological Essay on the Impact of Technology. Cambridge, Massachusetts: M. I. T. Press, 1969, 240.

140. Bernal, John D. Marx and Science. New York: International, 1952, 48.

141. Boguslaw, Robert. The New Utopians--A Study of System Design and Social Change. Englewood Cliffs, New Jersey: Prentice-Hall, 1965, viii, 213.

142. Boulding, Kenneth E. The Meaning of the 20th Century: The Great Transition. New York: Harper and Row, 1964, 208.

143. Boyko, Hugo, ed. Science and the Future of Mankind. Bloomington: Indiana University Press, 1964, viii, 380.

144. Brezezinski, Zbigniew. Between Two Ages: America's Role in the Technetronic Era. New York: Viking Press, 1970, 334.

145. Burke, John G., ed. The New Technology and Human Values. Belmont, California: Wadsworth, 1966, 408.

146. Calder, Nigel. Technopolis: Social Control of the Uses of Science. London: MacGibbon and Kee, 1969, 381.

147. Calder, Ritchie. Science in Our Lives. New York: New American Library, 1954, 192.

148. Charlesworth, J. C. and A. J. Eggers, Jr., eds. Harmonizing Technological Developments and Social Policy in America. Monograph II. Philadelphia, Pennsylvania: American Academy of Political and Social Science, 1970, 247.

149. Clarke, Arthur C. Voices from the Sky: Previews of the Coming Space Age. New York: Pyramid Books, 1967, 205.

150. Commoner, Barry. The Closing Circle: Nature, Man, and Technology. New York: Knopf, 1971, 326.

151. Cornelius, Benjamin A. Science, Technology, and Human Values. Columbia: University of Missouri Press, 1965, v, 296.

152. Cotgrove, Stephen and Steven Box. Science, Industry, and Society. London: Allen and Unwin; New York: Barnes and Noble, 1970, 211.

153. Darlington, Cyril D. The Conflict of Science and Society. London: Watts, 1948, 51.

154. Dubos, René. Reason Awake: Science for Man. New York: Columbia University Press, 1970, 280.

155. Ellul, Jacques. The Technological Society. Trans. by John Wilkinson. New York: Knopf, 1964, xxxvi, 449.

156. Feshback, Seymour and Robert D. Singer. Television and Aggression. San Francisco: Jossey-Bass, 1971, 186.

157. George, F. H. Science and the Crisis in Society. New York: Wiley-Inter-science, 1970, 180.

158. Ginsberg, Eli. Technology and Social Change. New York: Columbia University Press, 1964, vii, 158.

159. Gould, Jay M. The Technical Elite. New York: Augustus M. Kelley, 1966, 178.

160. Harvard University Program on Technology and Society. Implications of Biomedical Technology. Cambridge, Massachusetts: Harvard University Press, 1968, 53.

161. ________. Technology and the Individual. Cambridge, Massachusetts: Harvard University Press, 1970, 62.

162. ________. Technology and Values. Cambridge, Massachusetts: Harvard University Press, 1969, 55.

163. Mansfield, Edwin, ed. The Economics of Technological Change. New York: Norton, 1968, 257.

164. Marcuse, Herbert. One-Dimensional Man. Boston: Beacon Press, 1964, xvii, 260.

165. Meier, Richard L. Science and Economic Development: New Patterns of Living. Second Ed., Rev. Cambridge, Massachusetts: M.I.T. Press, 1966, 320.

166. Mesthene, Emmanuel G. Technological Change: Its Impact on Man and Society. Cambridge, Massachusetts: Harvard University Press, 1970, 127.

167. Meynaud, Jean. Technocracy. London: Faber, 1968, 315.

168. Moore, John A. Science for Society: A Bibliography. Washington, D. C.: American Association for the Advancement of Science, 1971, 76.

169. Morison, Elting E. Men, Machines, and Modern Times. Cambridge, Massachusetts: M. I. T. Press, 1966, ix, 235.

170. Mumford, Lewis. The Myth of the Machine: Technics and Human Development. New York: Harcourt, Brace, and World, 1967, 342.

171. National Research Council. Study Group on an Institute for Applied Science and Social Change in a Rural Area, Division of Behavioral Sciences. A National Rural Center: Applying Science to Improve the Quality of Rural Life. Washington, D.C.: National Research Council, 1970, 51.

172. Piccard, Paul J., ed. Science and Policy Issues: Lectures in Government and Science. Itasca, Illinois: F. E. Peacock, 1969, 156.

173. Platt, John R. The Step to Man. New York: Wiley, 1966, 240.

174. Reich, Charles A. The Greening of America. New York: Random House, 1970, 399.

175. Rostand, Jean. Can Man Be Modified. Trans. by Jonathan Griffin. New York: Basic Books, 1959, 105.

176. Stover, Carl F., ed. The Technological Order. Detroit: Wayne State University Press, 1963, xii, 280.

177. Stratton, Julius A. Science and the Educated Man. Cambridge, Massachusetts: M. I. T. Press, 1966, 186.

178. Taubenfield, Howard J., ed. Space and Society. Dobbs Ferry, New York: Oceana, 1964, 196.

179. Taylor, Gordon R. The Biological Time Bomb. London: Thames and Hudson, 1968, 240.

180. Toffler, Alvin. Future Shock. New York: Random House, 1970, 505.

181. Vickers, G. Science and the Regulation of Society. New York: Institute for the Study of Science in Human Affairs, Columbia University, 1970, 56.

182. Walker, Charles R., assisted by Adelaide G. Walker, eds. Modern Technology and Civilization: An Introduction to Human Problems in the Machine Age. New York: McGraw-Hill, 1962, xi, 469. Biblio.

183. Warner, Aaron W., Dean Morse, and Alfred S. Eichner, eds. The Impact of Science on Technology. Edited for the Columbia University Seminar on Technology and Social Change. New York: Columbia University Press, 1965, 221.

184. Wiener, Norbert. The Human Use of Human Beings--Cybernetics and Society. Boston: Houghton Mifflin, 1950, 241.

LEADING QUESTIONS

1. Must a "technological society" emerge from the uncontrolled advance of technology? Are there factors common to modern industrialism, collectivism, democratic centralism, and utilitarianism that result primarily from the influence of technology?

2. "Technique," says Jacques Ellul, "is opposed to nature...technique as art is the creation of an artificial system." Is this an invincible thesis? Are there other interpretations of comparable validity?

3. What factors determine the course of technological innovation? Why are some technological possibilities neglected and why have some been suppressed?

4. What is meant by "technocracy"? Who are its prophets? What are its promises? What are its prospects? Who are the "technocrats"?

5. Do you think that the current disenchantment with science and technology is a temporary phenomenon, or does it represent a fundamental change in outlook? What could be the consequences for society of such a change?

6. Is "imbalance" a meaningful concept in relation to science and technology? What would be the criteria for ascertaining a proper balance?

7. What are the principal social trends induced by science-based technology? What are the implications of these trends for higher education, for scientific research, and for human social organization?

8. Why do perceptive students of technology (e.g., John Diebold, Cybernetica, VIII, 150-156; or Robert Boguslaw, The New Utopians) urge the need for social innovation to match the pace of technological innovation? If Ellul is correct in asserting that technology shapes society, is it feasible to seek a non-technological countervailing force?

9. Is it possible to introduce technical change without destroying cherished beliefs and patterns of life?

10. Is deliberate and considered control over the direction of scientific and technological growth possible or desirable? What would be the principal dangers? What would be the necessary conditions for effective social control? For control that is also socially beneficial?

TOPIC 04 SCIENTIFIC WORK IN TECHNOLOGICAL SOCIETIES

In technological societies, work is increasingly planned and directed by persons with special competence in science or technology. In these societies growing numbers of people are employed in scientific and technical activities [illegible] large number of new science-related occupations have arisen.

It is difficult [illegible] describe scientific work by classifying the workers. Distinctions among the several types of scientific workers are as much cultural as functional. Historical usage has differed among countries, so that we cannot use the English word "scientist", or its nearest counterparts in other languages, to classify a group of scientific workers that informed people everywhere would recognize as an identical occupational grouping. For example, the Russian nearest equivalent to the word "scientist" is applied to a wide range of scholars, engineers, and advanced biomedical and technical personnel who are not customarily classified as scientists [illegible] the United States or Western Europe. The American tendency has been to restrict the designation "scientist" to the physical sciences and to those fields of biology most closely related to physics and chemistry. With the possible exception of physical anthropology, which uses exact measurements, social and behavioral science professionals are classed as scientists only in a qualified sense. But regardless of designation, the knowledge and competence of technoscientific manpower has now become a major economic resource for national governments. In [illegible] national states, public expenditures for education and training in science and technology are increasingly viewed as public investments. In the tech[illegible]scientific superculture, wealth and power are inseparable from knowledge and performance effectiveness.

From its very beginnings modern science has been an enterprise of associations [illegible] well as of individuals. Scientific and technical work is today highly organized, [illegible] finds means for professional communication in the thousands of scientific and technical journals, congresses, symposia, and proceedings of scholarly meetings. The dissemination, storage, and retrieval of scientific and technical information has become one of the most distinctive and essential tasks of modern society. Scientific work is increasingly carried on through institutions for research and development and through large-scale cooperative programs. For more detail on institutional aspects of science see Topics 09, 12, and 15.

As organized forces of information and respected opinion, the scientists and their related professional associates influence public policy for science and technology. Accustomed to evaluating evidence on a basis of demonstrable fact rather than on the basis of popular preference, they sometimes find themselves in conflict with political values. The proper role of scientists in the politics of modern societies has aroused special interest, for it seems certain that science will be involved in many ways with the politics of the future.

TOPIC 04 SCIENTIFIC WORK IN TECHNOLOGICAL SOCIETIES

Selected Basic Readings:

Beer, John J. and W. David Lewis. "Aspects of the Professionalization of Science," Daedalus, XCII (Fall, 1963), 764-784.

Cartter, Allan M. "Scientific Manpower for 1970-1985," Science, CLXXII (April 9, 1971), 132-140.

Haberer, Joseph. "Politics and the Community of Science," American Behavioral Scientist, X (May, 1967), 10-12; 21-23.

Polanyi, Michael. "The Republic of Science: Its Political and Economic Theory," Minerva, I (Autumn, 1962), 54-73.

Ziman, John M. "Social Responsibility (I): The Impact of Social Responsibility on Science," Impact of Science on Society, XXI (April-June, 1971), 113-122.

Supplementary and Substitute Readings:

Allison, David. "The Industrial Scientist," International Science and Technology, Number 62 (February, 1967), 20-31.

Florey, Lord. "Role of the Scientist in Modern Society: The First Three Hundred Years," Perspectives in Biology and Medicine, VIII (Spring, 1965), 279-288.

Merton, Robert K. and Richard Lewis. "The Competitive Pressures (I): The Race for Priority," Impact of Science on Society, XXI (April-June, 1971), 151-161.

Piganiol, Pierre. "The Competitive Pressures (II): The Effects of Publish or Perish," Impact of Science on Society, XXI (April-June, 1971), 163-171.

Price, Derek J. de Solla. Little Science, Big Science. New York: Columbia University Press, 1963, 119.

TOPICAL OUTLINE	REFERENCE KEY
I. Scientific and Technical Manpower in Modern Society	38, 68, 251, 260, 277, 307
A. Growing number and importance of scientific and technical occupations	
1. Science-based technology supersedes art, craft, and tradition	
a. Industry, from the Industrial Revolution	
b. Warfare and defense	
c. Agriculture	
d. Transportation	
e. Consumer services and goods	
2. Increasing social and economic dependence on new and highly interdependent science-based technologies	
B. Scientific and technical manpower as "capital" assets	171, 200, 232, 264, 265
1. Increasing identification of science-derived technology as the basis of economic growth and "progress"	41, 125, 251, 281
2. Problems of developing and maintaining scientific and technical manpower	22, 23, 155, 196
a. Identification of talent	192, 193, 197
b. Incentive	5
c. Special educational provisions	20, 119, 164
d. The "Brain Drain"	8, 54, 69, 86, 132, 135
e. Women in scientific professions	145, 148, 169, 254
3. Unemployment among scientists and engineers caused by	38, 142, 191, 210, 268, 269
a. Cut-back in aerospace and defense-related research	
b. Highly specialized training of the unemployed	
c. "Over-qualification" for many jobs	

II. Science and Professionalism — 11, 15, 221, 240, 247

A. Characteristics of a profession — 150, 160, 253
1. Example: old idea of the "Three Professions": theology, law, and medicine
2. Standards of preparation and work
3. Professional ethics — 198, 272
4. Contrast with amateurism — 181

B. Science-based occupations and professions
1. Medicine and biomedical technologies — 119
2. Engineering specializations — 223
3. Education and training (Cf. Topic 05)
4. Social-psychological specialization

C. Professional scientists — 151, 165, 168, 240, 247
1. What is a scientist and who are scientists? — 80, 165, 177, 201, 203, 306
2. Popular images of scientists — 10, 134, 195
3. From amateur to professional — 181, 286
4. One profession or many? — 242
5. Technicians in the sciences — 200

III. Scientific and Professional Societies--Organized Scientists--an illustrative survey — 30, 56, 161, 219, 240, 257

A. Societies of Scientists and other Scholars--Prototypes: — 273
1. Accademia Secretorum Natural--Naples, 1560
2. Accademia dei Lincei--Rome, 1603
3. Accademia del Cimento--Florence, 1651
4. Royal Society--London, 1662
5. Academie des Sciences--Paris, 1666
6. Russian Academy of Sciences--St. Petersburg, 1724
7. American Philosophical Society--1743

B. Types of Scientific and Professional Societies — 259
1. Societies of science specialists--USA — 207
   a. Physical
      (1) American Astronomical Society
      (2) American Chemical Society

(3) American Physical Society
(4) Geological Society of America
b. Biological
(1) American Physiological Society
(2) American Society for Microbiology
(3) American Society of Zoologists
(4) Ecological Society of America
c. Behavioral and social
(1) American Anthropological Association
(2) American Psychological Association
(3) American Economic Association
(4) American Political Science Association
(5) American Sociological Association
d. Science-related technical and professional
(1) American Association of Petroleum Geologists
(2) American Forestry Association
(3) American Medical Association
(4) American Society of Civil Engineers
(5) Institute of Electrical and Electronics Engineers

2. Federations of scientific societies
a. National--USA

(1) American Association for the Advancement of Science	14, 142, 146
(2) American Institute of Biological Sciences	47, 212
(3) American Institute of Physics	9, 109
(4) Engineers Joint Council	
b. International unions and associations	42, 289
(1) International Council of Scientific Unions	7, 21, 27, 292
(2) International Union for Conservation of Nature and Natural Resources	12, 245
(3) International Social Science Council	
3. Honorary societies and academies	188
a. National Academy of Science	43, 176
b. National Academy of Engineering	

4. Science professionals and occupational unionism--Federation of American Scientists 36, 81, 178, 179, 305

5. Politically oriented societies--Scientists and Engineers for Social and Political Action (SESPA) 159, 178

IV. Scientific Publications: Professional, Technical, Philosophical, and Historical 238, 308

A. Prototypes:
<u>Journal des Savants</u>--Paris, 1665
<u>Philosophical Transactions of the Royal Society</u>--London, 1665

B. Purposes 152, 217
1. To disseminate information
2. To establish priority in research
3. To establish communication between workers in a particular specialty
4. Sometimes to relate specialties to larger fields of interest

C. Types of journal publications 161
1. General professional publications, e.g., <u>Science</u>, <u>Nature</u>, <u>Advancement of Science</u>, <u>Scientific American</u>, <u>American Scientist</u> 139
2. Specialized publications (various levels), e.g., <u>Journal of the American Chemical Society</u>, <u>Analytic Chemistry</u>, <u>Chemical Reviews</u>, <u>Chemical and Engineering News</u>, <u>American Behavioral Scientist</u>, <u>Bioscience</u>, <u>Physical Review</u>
3. Philosophical and historical, e.g., <u>Cybernetica</u>, <u>Isis</u>, <u>Minerva</u>, <u>Journal of the Philosophy of Science</u>, <u>Technology and Culture</u>, <u>Perspectives in Biology and Medicine</u>

4. Public issues and policies in science, e.g., Science and Public Affairs: Bulletin of the Atomic Scientists, Impact of Science on Society, Minerva, Environment, New Scientist and Science Journal

D. Other scientific publications — 37

1. Transactions of learned societies and of scientific meetings--symposia, colloquia, proceedings
2. Reports and investigations by professional scientific groups as individuals--including government documents, e.g., reports of panels of the President's Science Advisory Committee, National Academy of Sciences, and Congressional inquiries and hearings
3. Abstracting and citation systems and services, e.g., Biological Abstracts, Chemical Abstracts, Current Contents, Nuclear Science Abstracts, Science Citation Index — 49, 73, 140, 144, 225
4. Monographs and systematic works
   a. Single-author works
   b. Multi-author works
   c. Textbooks
   d. Dissertations--published and unpublished
5. Encyclopedic works, e.g., Encyclopedia of the Social Sciences, Handbook of Physiology
6. Manufacturers' technical publications
   a. House organs
   b. Brochures and pamphlets

E. Some growing problems of scientific publication as a means of communication and information — 29, 115, 145, 206, 208, 212, 213, 258

1. The quantitative problem — 128, 194, 266, 293

   a. Increase in the numbers of specialties and specialized publications
   b. Volume of research and publications

2. Timeliness--the importance of correspondence and word-of-mouth in rapidly developing fields 270
3. The referee system
4. Semantic difficulties growing out of specialization in research and in languages
5. Information search, collation, and retrieval systems--aids in the management of knowledge 1, 6, 17, 21, 27, 37, 44, 57, 73, 108, 109, 110, 143, 163, 184, 291

V. Institutionalization of Scientific Work
(See Topics under Section II--"The Organization of Science and Technology") 234, 266

A. Types of institutional structures (USA)
1. Non-governmental institutions established by scientists
   a. Institute of Ecology. 235
   b. Salk Institute
   c. Hudson Institute
2. Not-for-profit research and development corporations 53, 187
   a. Battelle Memorial Institute
   b. Rand Corporation 202
   c. Brookings Institution
3. Industrial laboratories
   a. Bell Telephone Laboratories
   b. General Electric Knolls Laboratory
   c. IBM Watson Research Center
4. Government bureaus and laboratories (Cf. Topic 06) 261, 297, 301
   a. National Bureau of Standards
   b. National Oceanic and Atmospheric Administration (NOAA) 40, 45, 295, 296, 297, 299
   c. Argonne, Brookhaven, Los Alamos, and Oak Ridge National Laboratories 290
5. Ad hoc and cooperative programs (Cf. Topic 09)

B. Problems of institutionalized work (Cf. Topics 11 and 12) — 25, 240

1. Facilitating scientific creativity (Cf. Topic 15) — 300
   a. Fostering a climate for creativity — 275
   b. Promoting multi-disciplinary synthesis — 302
2. Protecting integrity and objectivity of science from — 39, 87, 226, 241, 279
   a. Political interference
   b. Bias or irresponsibility of scientists
3. Maintaining continuing viability of research institutions — 290
   a. Program obsolescence in mission-oriented institutions — 137, 164
   b. Personnel obsolescence in scientific work (Cf. Topic 05) — 52
4. Obtaining adequate financial support
   a. Effects of government appropriations policies on continuity and quality of scientific work — 256
   b. Effects of recourse to private funding
      (1) Industrial
      (2) Philanthropic
   c. Problems of endowed research

VI. Science Professionals in Technological Societies — 19, 33, 60, 61, 68, 75, 91, 153, 186, 218, 220, 229, 230, 282, 284, 307

A. The status of science professionals — 70, 94, 97, 101, 124, 263, 267

1. Elitism--real problem or subjective phobia: — 228
   a. The "New Priesthood"--concept and criticism — 247, 249
   b. The technocrats
   c. Distinguishing characteristics of a scientific elite group — 240, 286
   d. The contrasting status of scientists, physicians, engineers, and technicians — 59, 62, 107, 139, 189, 231, 250

2. Relation of science professionals to	287
a. Other occupational groups	
b. Public officials--legislators and judges	25, 51, 216, 239
c. The news media (Cf. Topic 01)	
d. The public at large (Cf. Topic 01)	14, 205
e. Each other	32, 150, 243, 306
B. Contrasts in organizational and professional orientation and values (See also Topic 15)	13, 89, 113, 190, 231, 274, 275
1. Professional-managerial conflict in	
a. Government laboratories	137, 244, 300, 301
b. Industrial research and development	118, 248
c. Hospitals	
d. Military organizations	
2. Varied roles of the scientist in	
a. Academia	48, 77, 92, 188
b. Government	28, 127, 262, 267
c. Industry	46, 100, 188
3. The scientist as administrator	26, 76, 95
4. Science professionals in public affairs (See also Topic 11: The Politics of Science and Technology)	31, 87, 120, 158, 204, 226, 228, 239, 241, 304
a. The scientist as politician	116, 130, 147, 288
(1) In partisan affairs	114
(2) As consultant and advisor	2, 26, 246
b. The social responsibility of scientists	24, 39, 64, 79, 93, 98, 102, 112, 167, 182, 214, 222
(1) Role in international affairs (See also Topic 09)	50, 70, 83, 84, 103, 104, 106, 123, 174, 185, 283
(2) The "Pugwash" syndrome	58, 63, 67, 126, 156, 170, 172, 173, 180, 280
(3) Defense-oriented research	16, 66, 71, 88, 117, 121, 142, 162, 279

(4) Politically "sensitive" topics, e.g., crime, intelligence, poverty, race (Cf. Topic 14)

(5) Guidance for public and official opinion provided by scientific societies and institutions — 159, 183, 219, 241, 282

(i) Center for Science in the Public Interest — 99

(ii) Institute of Society, Ethics and the Life Sciences — 35

C. Some problems of science professionals in technoscientific societies — 133, 149, 227

1. Dependence for financial support on a source (the state) which is frequently changing its patterns of funding — 90, 299
2. Excessive secrecy in many governmental and industrial organizations — 34
3. Prestige and remuneration in some fields, and not in others — 250
4. Acceptability of political views of scientists for many top jobs in government
5. Conflicts of loyalty, and ethical problems e.g., in "defense"-oriented research — 131, 199
6. Race for priority in important fields of research — 74, 133
7. The pressure of "Publish or Perish" — 18
8. Keeping up with new knowledge in fields of interest — 96, 270

BIBLIOGRAPHY

General References: Articles

1. Abreu, Jean-Charles. "Twenty Years in a Second," Ceres, I (May-June, 1968), 25-28.

2. Allison, David. "The Affluent Consultants," International Science and Technology, Number 10 (October, 1962), 50-54.

3. ________. "Educating the Engineer," International Science and Technology, Number 18 (June, 1963), 26-38.

4. ________. "The Industrial Scientist," International Science and Technology, Number 62 (February, 1967), 20-31.

5. Appleton, Edward. "Shortages of Science Applicants to Universities," Nature, CCV (January 16, 1965), 232-233.

6. Arnett, Edward M. "Computer-Based Chemical Information Services," Science, CLXX (December 25, 1970), 1370-1376.

7. Atwood, Wallace W. "International Council of Scientific Unions," Science, CXXVIII (December 19, 1958), 1558-1561.

8. Baldwin, George B. "Brain Drain or Overflow?" Foreign Affairs, XLVIII (January, 1970), 358-372.

9. Barton, H. A. "The Story of the American Institute of Physics," Physics Today, IX (January, 1956), 56-66.

10. Beardslee, David C. and Donald D. O'Dowd. "The College Student Image of the Scientist," in The Sociology of Science, ed. by Bernard Barber and Walter Hirsch. New York: Free Press of Glencoe, 1962, 247-258.

11. Beer, John J. and David W. Lewis. "Aspects of the Professionalization of Science," Daedalus, XCII (Fall, 1963), 764-784.

12. Berwick, E. J. H. "The International Union for Conservation of Nature and Natural Resources: Current Activities and Situations," Biological Conservation, I (April, 1969), 191-199.

13. Best, Robert D. "The Scientific Mind vs. the Management Mind," Industrial Research, V (October, 1963), 50-52.

14. Bevan, W. "The General Scientific Association: A Bridge to Society at Large," Science, CLXXII (April 23, 1971), 349-352.

15. Beveridge, William I. B. "Scientists," in his The Art of Scientific Investigation. Revised Edition. New York: Norton, 1957, 139-159.

16. Blackett, Patrick M. S. "Tizard and the Science of War," Nature, CLXXXV (March 5, 1960), 647-653.

17. Boulding, Kenneth E. "A Data-Collecting Network for the Sociosphere," Impact of Science on Society, XVIII (April-June, 1968), 97-101.

18. Boutry, G. A. "Quantity versus Quality in Scientific Research (II): The Paper Explosion," Impact of Science on Society, XX (July-September, 1970), 195-206.

19. Bovet, Daniel. "Role of the Scientist in Modern Society--A Symposium: Part I," Perspectives in Biology and Medicine, VIII (Summer, 1965), 533-545.

20. Boyle, Edward. "Technical Education in Britain," Nature, CXCVIII (April 27, 1963), 334-336.

21. Brabyn, H. "UNISIST for World Science," New Scientist and Science Journal, XLIX (March 11, 1971), 568-569.

22. Brode, Wallace R. "Approaching Ceilings in the Supply of Scientific Manpower," Science, CXLIII (January 24, 1964), 313-324.

23. ________. "Manpower in Science and Engineering, Based on a Saturation Mode," Science, CLXXIII (July 16, 1971), 206-213.

24. Brodine, Virginia. "Crisis in the Environment: The Scientists' Responsibility," Scientist and Citizen, IX (October, 1967), 188-190.

25. Bronk, Detlev W. "The Role of Scientists in the Furtherance of Science," Science, CXIX (February 19, 1954), 223-227.

26. Brown, Harold. "Confessions of an Ex-Physicist," Physics Today, XIX (June, 1966), 45-50.

27. Brown, Harrison. "International Cooperation: The New ICSU Program on Critical Data," Science, CLVI (May 12, 1967), 1153-1159.

28. Brown, Paula. "Bureaucracy in a Government Laboratory," Social Forces, XXXII (March, 1954), 259-268.

29. Brown, W. S., John R. Pierce, and Joe F. Traub. "The Future of Scientific Journals," Science, CLVIII (December 1, 1967), 1153-1159.

30. Bulletin of the Atomic Scientists. "The Scientists' Organizations in 1950," Bulletin of the Atomic Scientists, VII (January, 1951), 23-27.

31. Bundy, McGeorge. "The Scientist and National Policy," in Knowledge and Power: Essays on Science and Government, ed. by Sanford A. Lakoff. New York: Free Press, 1966, 420-431.

32. Bush, Vannevar. "Professional Collaboration," Science, CXXV (January 11, 1957), 49-54.

33. ________. Scientists and Their Dreams," American Scientist, LIX (November-December, 1971), 674-677.

34. Cade, Joseph A. "Aspects of Secrecy in Science," Impact of Science on Society, XXI (April-June, 1971), 181-190.

35. Callahan, D. "Profile: Institute of Society, Ethics, and the Life Sciences," BioScience, XXI (July 1, 1971), 735-737.

36. Carpenter, Morris T. "Unionization of Professional Personnel: A Case History," Research Management, II (Winter, 1959), 221-230.

37. Carter, Launor F. "National Document-Handling Systems in Science and Technology," Science, CLIV (December 9, 1966), 1299-1304.

38. Cartter, Allan M. "Scientific Manpower for 1970-1985," Science, CLXXII (April 9, 1971), 132-140.

39. Chain, Ernst B. "Social Responsibility and the Scientist," New Scientist, XLVIII (October 22, 1970), 168-170.

40. Chase, J. "NOAA and Oceanographic Research--Wet NASA Idea Dries Up," Science, CLXXIII (July 16, 1971), 216-217; 220-221.

41. Chastain, Clark E. "Science, Technology, and Economic Growth," Impact of Science on Society, XIV (Number 4, 1964), 239-248.

42. Cleland, Ralph E. "The International Union of Biological Sciences," AIBS Bulletin (BioScience), VI (June, 1956), 10-11.

43. Cohn, V. "The House of Lords of Science," Technology Review, LXXIII (June, 1971), 8-9.

44. Collier, H. R. "Federal Research Programs and a Proposal for a National Research Data Bank," Congressional Record, Part I: CXVII (June 8, 1971), E5544-E5551; Part II: CXVII (June 9, 1971), E5640-E5650; Part III: CXVII (June 11, 1971), E5729-E5740.

45. Congressional Record. "The National Oceanic and Atmospheric Administration," Congressional Record, CXVII (February 4, 1971), S841-S844.

46. Cotgrove, Stephen and Steven Box. "Scientists and Employers," New Scientist, XXII (May 7, 1964), 362-364.

47. Cox, Hiden T. "The AIBS after Ten Years," AIBS Bulletin (BioScience), IX (November, 1959), 19-21.

48. ________. "Scientists and Public Policy," AIBS Bulletin (BioScience), XIII (February, 1963), 14-16.

49. Crane, Evan J. "Scientists Share and Serve," Chemical and Engineering News, XXIX (October 15, 1951), 4250-4253.

50. Crook, Keith A. W. "Social Responsibility in Science; The Problem of Communication," Search, I (September, 1970), 120-124.

51. Daddario, Emilio Q. "Scientists and Legislatures," AIBS Bulletin (BioScience), XIX (February, 1969), 149-151.

52. Dalton, G. W. and P. H. Thompson. "Accelerating Obsolescence of Older Engineers," Harvard Business Review, XLIX (September-October, 1971), 57-67.

53. Danilov, Victor J. "The Not-for-Profit Research Institutes," Industrial Research, VIII (February, 1966), 30-34; 36-39.

54. Dedijer, Stevan. "The Brain Drain: An Age-Old Problem," Bulletin of the Atomic Scientists, XXVI (March, 1970), 9-11.

55. ________. "Migration of Scientists: A World-Wide Phenomenon and Problem," Nature, CCI (March 7, 1964), 964-967.

56. DeGrazia, Alfred. "A Concept of Scientists and Their Organizations," American Behavioral Scientist, VI (December, 1962), 30-34.

57. Dingell, J. D. "To Provide for a National Environmental Data System," Congressional Record, CXVII (May 17, 1971), H3969-H3973.

58. Doty, P. "The Community of Science and the Search For Peace," Science, CLXXIII (September 10, 1971), 998-1002.

59. Drucker, Daniel C. "The Engineer in the Establishment," Bulletin of the Atomic Scientists, XXVII (December, 1971), 31-34.

60. Dryden, Hugh L. "The Scientist in Contemporary Life," Science, CXX (December 24, 1954), 1052-1055.

61. Dubos, René. "Scientist and the Public," Science, CXXXIII (April 21, 1961), 1207-1211.

62. Duffy, John. "The Changing Image of the American Physician," Journal of the American Medical Association, CC (April 3, 1967), 30-34.

63. Dyson, Freeman J. "Pugwash, 1962," Physics Today, XV (November, 1962), 24-26.

64. Einstein, Albert. "On the Moral Obligation of the Scientist," Impact of Science on Society, I (October-December, 1950), 104-105.

65. Farris, H. W. "The Campus and Industry," Industrial Research, VI (April, 1964), 76-81.

66. Feld, Bernard T. "Scientist's Role in Arms Control," Bulletin of the Atomic Scientists, XXVI (January, 1970), 7-8; 47.

67. ________. "The 21st Pugwash Conference on Science and World Affairs," Science, CLXXIV (December 10, 1971), 1150-1156.

68. Florey, Howard W. "Role of the Scientist in Modern Society: The First Three Hundred Years," Perspectives in Biology and Medicine, VIII (Spring, 1965), 279-288.

69. Fortney, Judith A. "International Migration of Professionals," Population Studies, XXIV (July, 1970), 217-232.

70. France, Boyd. "Science at State: A Crisis of Status," Scientific Research, II (April, 1967), 47-50.

71. Frisch, David H. "Scientists and the Decision to Bomb Japan," Bulletin of the Atomic Scientists, XXVI (June, 1970), 107-115.

72. Galloway, Eilene. "Scientific Advice for Congress: Analysis of Three Proposals," in Knowledge and Power: Essays on Science and Government, ed. by Sanford A. Lakoff. New York: Free Press of Glencoe, 1966, 359-376.

73. Garfield, E. "Citation Index for Studying Science," Nature, CCXXVII (August 15, 1970), 669-[illegible].

74. Gaston, Jerry. "Secretiveness and Competition for Priority of Discovery in Physics," Minerva, IX (October, 1971), 472-492.

75. Gell-Mann, M. "How Scientists Can Really Help," Physics Today, XXIV (May, 1971), 23-25.

76. Gibbons, Charles C. "The Scientist as Administrator," Research Management, VI (November, 1963), 425-433.

77. Glass, H. Bentley. "The Academic Scientist, 1940-1960," Science, CXXXII (September 2, 1960), 598-603.

78. Gmitter, George T. "The Industrial R & D Scientist and His Environment," Research Management, IX (March, 1966), 115-131.

79. Godwin, Harry. "The Personality of Botany: The Reciprocal Responsibility," Nature, CCIV (October 3, 1964), 9-12.

80. Goodrich, Hubert R., Robert H. Knapp, and George A. W. Boehm. "The Origins of U. S. Scientists," Scientific American, CLXXXV (July, 1951), 15-17.

81. Graham, David M. "Organizing Scientists and Engineers," Industrial Research, IX (March, 1967), 92-96.

82. Granzeir, Frank J. "Should Scientists Be Licensed?" Industrial Research, VII (September, 1965), 100-103.

83. Greenwood, J. W. "The Science Attaché: Who He Is and What He Does," Science Forum, IV (April, 1971), 21-25.

84. ______. "The Scientist-Diplomat: A New Hybrid Role in Foreign Affairs," Science Forum, IV (February, 1971), 14-18.

85. Gross, Paul M. "The Fifth Estate in the Seventh Decade--The Status of Science and Scientists in the 1960's Reviewed," Science, CXLII (January 3, 1964), 13-20.

86. Grubel, Herbert G. "Foreign Scientists in the United States," Bulletin of the Atomic Scientists, XXVI (April, 1970), 9-12.

87. Haberer, Joseph. "Politics and the Community of Science," American Behavioral Scientist, X (May, 1967), 10-12; 21-23.

88. Halsted, Thomas A. "Lobbying against the ABM," Bulletin of the Atomic Scientists, XXVII (April, 1971), 23-28.

89. Hamilton, D. "Technological Philosopher," New Scientist and Science Journal, L (April 15, 1971), 162-165.

90. Handler, Philip. "The Federal Government and the Scientific Community," Science, CLXXI (January 15, 1971), 144-151.

91. ______. "Science's Continuing Role," AIBS Bulletin (BioScience), XX (October 15, 1970), 1101-1106.

92. Haworth, Leland J. "Scientists and Society," Physics Today, XVI (July, 1963), 19-22.

93. Hayes, John R. "Research, Teaching, and Faculty Fate," Science, CLXXII (April 16, 1971), 227-230.

94. Healey, Frank H. "Job Status for the Research Scientist," Research Management, III (Winter, 1960), 239-244.

95. Hereim, Andrew T. "Are Scientists Becoming Administrators?" American Scientist, L (December, 1962), 355A-360A.

96. Herschman, Arthur. "Keeping Up with What's Going on in Physics," Physics Today, XXIV (November, 1971), 23-29.

97. Heymans, Corneille. "Role of the Scientist in Modern Society--A Symposium, Part III," Perspectives in Biology and Medicine, VIII (Summer, 1965), 554-558. Discusses the role of medical scientists.

98. Hinshelwood, Cyril. "The Scientist and the Future," New Scientist, VIII (July 21, 1960), 228-231.

99. Holden, C. "Public Interest: New Group Seeks Redefinition of Scientists Role," Science, CLXXIII (July 9, 1971), 131-132.

100. Hooker, S. G. and N. Kurti. "Engineers and Scientists in Industry," Nature, CCXVII (February 17, 1968), 609-611.

101. Houssay, Bernardo A. "Role of the Scientist in Modern Society--A Symposium: Part II," Perspectives in Biology and Medicine, VIII (Summer, 1965), 546-553.

102. Hutchinson, Eric. "Science and Responsibility," American Scientist, LII (March, 1964), 40A-46A.

103. Johnson, Bryan L. "The Changing Role of Scientists in International Affairs," American Scientist, LII (June, 1964), 138A-145A.

104. Kilborn, P. "Science Makes the Embassy Scene," Scientific Research, III (May 13, 1968), 39-41.

105. Kipp, Egbert M. "Introduction of the Newly Graduated Scientist to Industrial Research," Research Management, III (Spring, 1960), 39-47.

106. Kistiakowsky, George B. "Science and Foreign Affairs," Science, CXXXI (April 8, 1960), 1019-1024.

107. Kleingartner, Archie and James L. Koch. "Technicians--An Identity Crisis," Industrial Research, XI (November, 1969), 54-56.

108. Koch, H. William. "Age of Change; Role of AIP," Physics Today, XXIII (January, 1970), 27-32.

109. ________. "Current Physics Information," Science, CLXXIV (November 26, 1971), 918-922.

110. ________. "A National Information System for Physics," Physics Today, XXI (April, 1968), 41-49.

111. Kranzberg, Melvin. "Scientists: The Loyal Opposition," American Scientist, LX (January-February, 1972), 20-23.

112. Krasner, Leonard. "The Behavioral Scientist and Social Responsibility: No Place to Hide," Journal of Social Issues, XXI (April, 1965), 9-30.

113. Kruytbosch, Carlos E. and Sheldon S. Messinger. "Unequal Peers: The Situation of Researchers at Berkeley," American Behavioral Scientist, XI (May-June, 1968), 33-43.

114. Lakoff, Sanford A. "The Scientific Establishment and American Pluralism," in Knowledge and Power: Essays on Science and Government, ed. by Sanford A. Lakoff. New York: Free Press, 1966, 377-392.

115. Lamb, Arthur B. "Publication--Lifeblood of Science," Chemical and Engineering News, XXVII (October 3, 1949), 2841-2844, 2876.

116. Langer, Elinor. "Scientist in Politics," Science, CXLV (August 7, 1964), 561-563.

117. ________. "A West Coast Version of the March 4 Protest... At Stanford--Convocation, Not Confrontation," Science, CLXIII (March 14, 1969), 1176-1177.

118. La Porte, Todd R. "Conditions of Strain and Accommodation in Industrial Research Organizations," Administrative Science Quarterly, X (June, 1965), 21-38.

119. Lee, Philip R. "New Demands for Medical Manpower," Journal of the American Medical Association, CXCVIII (December 5, 1966), 1091-1093.

120. Leiserson, Avery. "Scientists and the Policy Process," American Political Science Review, LIX (June, 1965), 408-416.

121. Leitenberg, Milton. "Social Responsibility (II): The Classical Scientific Ethic and Strategic Weapons Development," Impact of Science on Society, XXI (April-June, 1971), 123-136.

122. Lerner, Daniel and Albert H. Teich. "Internationalism and World Politics among CERN Scientists," Bulletin of the Atomic Scientists, XXVI (February, 1970), 4-10.

123. Long, Franklin A. "Scientists in Foreign Affairs: Where Do We Go Now?" Bulletin of the Atomic Scientists, XXIII (March, 1967), 14-18.

124. Lonsdale, Kathleen. "Scientists and the People," Bulletin of the Atomic Scientists, XIV (September, 1958), 242-245.

125. Macdonald, J. Ross. "Variables Affecting Supply and Demand of Scientists and Engineers--The User's Viewpoint," Research Management, X (May, 1967), 195-209.

126. McElheny, V. K. "Pugwash: Few Cheers for S.A.L.T.," Technology Review, LXXIII (December, 1970), 10-11.

127. Macy, John W. "The Scientists in the Federal Service," Science, CXLVIII (April 2, 1965), 51-54.

128. Maddox, John. "Journals and the Literature Explosion," Nature, CCXXI (January 11, 1969), 128-130.

129. Mather, Kirtley F. "Geology, Geologists, and the AAAS," Science, CXXIX (April 24, 1959), 1106-1111.

130. Meeker, D. Olan. "Doctors and Politics," Journal of the American Medical Association, CLXVI (March 15, 1958), 1313-1315.

131. Mellanby, K., Terence Price, and J. R. Ravetz. "Conflicts of Loyalty in Science," Nature, CCXXXIV (November 5, 1971), 17-21.

132. Mercier, Alvin. "Brains for Sale," Bulletin of the Atomic Scientists, XXIV (March, 1968), 38-46.

133. Merton, Robert K. and Richard Lewis. "The Competitive Pressures (I): The Race for Priority," Impact of Science on Society, XXI (April-June, 1971), 151-161.

134. Michael, Donald N. "Scientists through Adolescent Eyes: What We Need to Know, Why We Need to Know It," Scientific Monthly, LXXXIV (March, 1957), 135-140.

135. Mills, Thomas J. "Scientific Personnel and the Professions," Annals of the American Academy of Political and Social Science, CCCLXVII (September, 1966), 33-42.

136. Moulton, Forest R. "The American Association for the Advancement of Science: A Brief Historical Sketch," Science, CVIII (September 3, 1948), 217-218; "The AAAS and Organized American Science," Ibid. (November 26, 1948), 573-577.

137. Mueller, Marti. "Trouble at NASA: Space Scientists Resign," Science, CLXV (August 22, 1969), 776-779.

138. Nader, Ralph. "The Scientist and His Indentured Professional Societies," Bulletin of the Atomic Scientists, XXVIII (February, 1972), 43-44, 46.

139. Nature. Centenary Review, CCXXIV (November 1, 1969), 417-472. Extracts from early issues and historical articles.

140. ________. "Slowly but Steadily with Information," Nature, CCXXXIV (December 3, 1971), 268-269.

141. Nelson, B. "M.I.T.'s March 4: Scientists Discuss Renouncing Military Research," Science, CLXIII (March 14, 1969), 1175-1178.

142. ________. "A Surplus of Scientists? The Job Market Is Tightening," Science, CLXVI (October 31, 1969), 582-584.

143. OECD Observer. "A Scientific and Technical Information Policy," OECD Observer, Number 33 (April, 1968), 36-38.

144. Parkins, Phyllis V. "Bioscience Information Service of Biological Abstracts," Science, CLII (May 13, 1966), 889-894.

145. Parrish, John B. and Jean S. Block. "The Future for Women in Science and Engineering," Bulletin of the Atomic Scientists, XXIV (May, 1968), 46-49.

146. Peiss, Reuben. "Acquisition of Foreign Scientific Publications," Chemical and Engineering News, XXVIII (April 24, 1950), 1364-1366.

147. Peter, W. G., III. "Science and Political Power," BioScience, XXI (August, 1971), 14-15.

148. Phillips, Jean. "Women in Science," Science Journal, II (May, 1966), 88-91.

149. Piganiol, Pierre. "The Competitive Pressures (II): The Effects of Publish or Perish," Impact of Science on Society, XXI (April-June, 1971), 163-171.

150. Polanyi, Michael. "The Republic of Science: Its Political and Economic Theory," Minerva, I (Autumn, 1962), 54-73.

151. Policard, Albert. "Essay on the Psychology of Teamwork in Science: The Life of the Team," Impact of Science on Society, XV (January-March, 1965), 57-64.

152. Price, Derek J. de Solla. "Networks of Scientific Papers--The Pattern of Bibliographical References Inidcates the Nature of the Scientific Research Front," Science, CXLIX (July 30, 1965), 510-515.

153. Price, Don K. "Purists and Politicians," Science, CLXIII (January 3, 1969), 25-31.

154. ________. "The Scientific Establishment," Science, CXXXVI (June 29, 1962), 1006-1009.

155. Psacharopoulos, G. "On Some Positive Aspects of the Economics of the Brain Drain," Minerva, IX (April, 1971), 231-242.

156. Pugwash Newsletter. "Role of Science and Scientists in National and World Affairs," Pugwash Newsletter, VII (July, 1969), 4-15.

157. Pym, Denis. "Industrial Science and 'The System'," New Scientist, XXXVI (November 23, 1967), 485-487.

158. Rabinowitch, Eugene. "On the Sochi Conference," Bulletin of the Atomic Scientists, XXVI (April, 1970), 18-20.

159. Reese, K. M. "Scientific Societies and Public Affairs," Chemical and Engineering News, XLIX (May 3, 1971), 30-35.

160. Reif, Frederick "The Competitve World of Pure Science," Science, CXXIV (December, 1961), 1957-1962.

161. de Reuck, Anthony V.S. "Learned Societies as Publishers," Nature, CXCVII (February 2, 1963), 426-427.

162. Rhed, John A. "Technology's Fetus--The ABM," Industrial Research, XI (February, 1969), 62-63.

163. Riggs, F. [illegible]hn. "World Information Center," Bulletin of the Atomic Scientists, XXI (January, 1965), 34-35.

164. Ritterbush, Philip C. "Research Training in Government Laboratories in the United States," Minerva, IV (Winter, 1966), 186-201.

165. Roe, Anne. "A Psychologist Examines 64 Scientists," Scientific American, CLXXXVII (November, 1952), 21-25.

166. ________. "The Psychology of the Scientist," Science, CXXXIV (August 18, 1961), 456-459.

167. Rose, Steven and Hilary Rose. "Social Responsibility (III): [illegible] of the Neutrality of [illegible]nce," Impact of Science on Society, XXI [illegible] June, 1971), 137-1[illegible].

168. Ross, Sydney. "Scientist: The Story of a Word," Annals of Science, XVIII (June, 1962), 65-85.

169. Rossi, Alice S. "Women in Science: Why So Few?" Science, CXLVII (May 28, 1965), 1196-1202.

170. Rotblat, Joseph. "The Pugwash Conferences," New Scientist, IV (October 9, 1958), 1015-1018.

171. Rudd, Ernest. "The Rate of Economic Growth, Technology, and the Ph. D.," Minerva, VI (Spring, 1968), 366-387.

172. Russell, Bertrand. "The Social Responsibilities of Scientists," Science, CXXI (February 12, 1960), 391-392.

173. Salam, Abdus. "Philosophers as Kings," New Scientist, XVII (March 7, 1963), 515-516.

174. Schilling, Warner R. "Scientists, Foreign Policy, and Politics," American Political Science Review, LVI (June, 1962), 287-300.

175. Schwartz, Leonard E. "Perspectives on Pugwash," International Affairs, XLIII (July, 1967), 498-515.

176. Seitz, Frederick. "The National Academy of Sciences of the United States of America," Impact of Science on Society, XIV (Number 2, 1964), 74-82.

177. Shapiro, Theresa R. "What Scientists Look for in Their Jobs," Scientific Monthly, LXXVI (June, 1953), 335-340.

178. Shapley, Deborah. "FAS: Reviving Lobby Battles ABM, Scientists' Apathy," Science, CLXXI (March 26, 1971), 1224-1227.

179. Shea, Timothy E. "The Implications of Engineering Unionism--Western Electric Experience," Research Management, II (Autumn, 1959), 149-157.

180. Shils, Edward A. "The Profession of Science," Advancement of Science, (June, 1968), 469-480.

181. Shils, Edward A., ed. "American Visa Policy and Foreign Scientists," Bulletin of the Atomic Scientists, VIII (October, 1952), special issue.

182. Siekevitz, Philip. "Scientific Responsibility," Nature, CCXXVII (September 26, 1970), 1301-1303.

183. Simons, Howard. "The Academicians of Washington," New Scientist, XX (October 17, 1963), 136-139.

184. Simpson, Gustavus S., Jr. "The Evolving U. S. National Scientific and Technical Information System," Battelle Technical Review, XVII (May-June, 1968), 21-28.

185. Skolnikoff, Eugene B. "Scientific Advice in the State Department," Science, CLIV (November 25, 1966), 980-985.

186. Slobodkin, Lawrence B. "Scientific Sterility in Middle Age," American Scientist, LIX (November-December, 1971), 678-679.

187. Smith, Bruce. "The Non-Profit Research Corporations in the U.S.A.," New Scientist, XXX (June 30, 1966), 858-860.

188. Smith, J. F. Downie. "Academic and Industrial Research," Research Management, V (July, 1962), 257-275.

189. Snow, Charles P. "The Place of the Engineer in Society," Nature, CCX (April 16, 1966), 237-238.

190. Steele, Lowell W. "What's the Boss For?" International Science and Technology, Number 43 (July, 1965), 52-57.

191. Strassenburg, Arnold A. "Supply and Demand for Physicists," Physics Today, XXIII (April, 1970), 23-28.

192. Subarsky, Zachariah. "What Is Science Talent?" Scientific Monthly, LXVI (May, 1948), 377-382.

193. Taylor, Calvin W. and Robert L. Ellison. "Biographical Predictions of Scientific Performance," Science, CLV (March 3, 1967), 1075-1080.

194. Taylor, Robert S. "Planning a College Library for the Seventies," Educational Record, L (Fall, 1969), 426-431.

195. Tepperman, Jay. "The Research Scientist in Modern Fiction," Perspectives in Biology and Medicine, III (Summer, 1960), 547-559.

196. Terman, F. E. "Supply of Scientific and Engineering Manpower: Surplus or Shortage?" Science, CLXXIII (July 30, 1971), 399-405.

197. Terman, Lewis M. "Are Scientists Different?" Scientific American, CXCII (January, 1955), 25-29.

198. Thimann, Kenneth V. and Robert W. Krause. "The AIBS: Crises in Retrospect, and the Outlook," Science, CLIII (July 29, 1966), 507.

199. Thring, M. "A Hippocratic Oath for Applied Scientists," New Scientist, XLIX (January 7, 1971), 25-26.

200. Trytten, Merriam H. "Soviet and U.S. Professional and Technical Manpower," Science, CXXVI (July 5, 1957), 11-15.

201. Waksman, Selman A. "Searchers and Researchers," Perspectives in Biology and Medicine, VII (Spring, 1964), 309-320.

202. Walsh, John. "RAND: R&D Nonprofit Pioneered a New Kind of Organization, Served as a Model for Others," Science, CXLIV (May 29, 1964), 1112-1114; 1164; "RAND: After Nearly Two Decades of Success, R&D Nonprofit Faces New Tasks, New Rivals," Ibid. (June 5, 1964), 1205-1207.

203. Wark, I. W. "Scientific Research as a Career," Nature, CXCVII (February 23, 1963), 737-740.

204. Waterman, Alan T. "Scientists and the Making of National Policy," Science, CXLIV (June 19, 1964), 1438-1439.

205. Wheeler, F. "The Show Must Go On," New Scientist and Science Journal, L (April 22, 1971), 204-205.

206. Wiener, Norbert. "Intellectual Honesty and the Contemporary Scientist," American Behavioral Scientist, VIII (November, 1964), 15-18.

207. Wigodsky, Herman S. "Scientists, Scientific Societies, and the Armed Forces," Science, CX (August 15, 1949), 135-137.

208. Wilson, John H., Jr. "Better Written Journal Papers--Who Wants Them?" Science, CLXV (September 5, 1969), 986-987.

209. Wilson, Robert R. "The Conscience of a Physicist," Bulletin of the Atomic Scientists, XXVI (June, 1970), 30-34.

210. Wolfle, D. and Kidd, C. V. "The Future Market for Ph.D's," Science, CLXXIII (August 27, 1971), 784-793.

211. Zhmudsky, A. Z. "The Scientist's Responsibility towards Society," Impact of Science on Society, XIII (Number 4, 1963), 301-310.

212. Ziman, John M. "Information, Communication, Knowledge," Nature, CCXXIV (October 28, 1969), 318-326.

213. Ziman, John M. "New Knowledge for Old," Nature, CCXXVII (August 29, 1970), 890-894.

214. ________. "Social Responsibility (I): The Impact of Social Responsibility on Science," Impact of Science on Society, XXVII (April-June, 1971), 113-122.

215. Zuckerman, Harriet and Robert K. Merton. "Patterns of Evaluation in Science: Institutionalisation, Structure, and Functions of the Referee System," Minerva, IX (January, 1971), 66-100.

General References: Books

216. Alsop, Joseph and Stewart Alsop. We Accuse: The Story of the Miscarriage of American Justice in the Case of J. Robert Oppenheimer. New York: Simon and Schuster, 1954, 88.

217. Baker, John R. Freedom and Authority in Scientific Publication. Oxford: Society for Freedom in Science, 1954, 14.

218. Barber, Bernard and Walter Hirsch, eds. The Sociology of Science. New York: Free Press of Glencoe, 1962, 642.

219. Bates, Ralph S. Scientific Societies in the United States. Third Edition. Cambridge, Massachusetts: M. I. T. Press, 1965, 326.

220. Ben-Davis, J. The Scientist's Role in Society, a Comparative Study. Englewood Cliffs, New Jersey: Prentice-Hall, 1971, 207.

221. Beardsley, Edward H. The Rise of the American Chemistry Profession, 1850-1900. Gainesville: University of Florida Press, 1964, 76.

222. Brown, Martin, ed. The Social Responsibility of the Scientist. London: Collier-Macmillian, 1971, 282.

223. Calhoun, Daniel H. The American Civil Engineer. Cambridge, Massachusetts: Technology Press, 1960, xiv, 295.

224. Carter, Launor F., et al. National Document-Handling Systems for Science and Technology. New York: Wiley, 1967, 344.

225. Collison, Robert. Abstracts and Abstracting Services. Santa Barbara, California: Clio, 1971, 122.

226. Commoner, Barry. Science and Survival. New York: Viking Press, 1964, 150.

227. Cotgrove, Stephen and Steven Box. Science, Industry, and Society. London: Allen and Unwin, 1970, 211.

228. Cox, Donald W. America's New Policy-Makers: The Scientist's Rise to Power. New York and Philadelphia: Chilton, 1964, xiv, 298.

229. Crane, D. Sociology of Science: Bibliography. Cambridge, Massachusetts: Massachusetts Institute of Technology, 1971, 27.

230. Dalenius, T., A. Karlsson, and S. Malmquist. Scientists at Work. Stockholm: Almquist and Wiksell, 1970, 259.

231. Danielson, Lee E. Characteristics of Engineers and Scientists: Significance for Their Motivation and Utilization. Ann Arbor: Bureau of Industrial Relations, University of Michigan, 1960, viii, 136.

232. Dedijer, Stevan and L. Svennington, eds. Brain Drain and Brain Gain: A Bibliography on Migration of Scientists, Engineers, Doctors, and Students. Lund, Sweden: Research Policy Program, 1967, 48.

233. DeReuck, Anthony and Julie Knight, eds. Communication in Science: Documentation and Automation. Boston: Little, Brown 1967, 274.

234. Dickson, Paul. Think Tanks. New York: Atheneum, 1971, 370.

235. Ecological Society of America. National Institute of Ecology: An Operational Plan. New London, Connecticut: Ecological Society of America, 1970, 42.

236. Eisner, Henry, Jr. The Technocrats: Prophets of Automation. Syracuse, New York: Syracuse University Press, 1967, 252.

237. Feuer, Lewis F. The Scientific Intellectual: The Psychological and Sociological Origins of Modern Science. New York: Basic Books, 1963, xii, 441.

238. Fowler, Maureen J. Guides to Scientific Periodicals: Annotated Bibliography. London: Library Association, 1966, xvi, 318.

239. Gilpin, Robert and Christopher Wright, eds. Scientists and National Policy-Making. New York: Columbia University Press, 1964, viii, 408.

240. Glaser, Barney G.. Organizational Scientists: Their Professional Careers. Indianapolis: Bobbs-Merrill, 1964, xix, 140.

241. Haberer, Joseph. Politics and the Community of Science. New York: Van Nostrand Reinhold, 1969, 337.

242. Hagstrom, Warren O. The Scientific Community. New York: Basic Books, 1965, 320.

243. Heisenberg, Werner. Physics and Beyond: Encounters and Conversations. New York: Harper and Row, 1970, 247.

244. Hill, Karl, ed. The Management of Scientists. Boston: Beacon Press, 1964, xv, 143.

245. International Union for Conservation of Nature and Natural Resources. IUCN--Yearbook 1970. Ed. by Robert I. Standish. Morges, Switzerland: IUCN, 1971, 98.

246. Jacobson, Harold K. and Eric Stein. Diplomats, Scientists, and Politicians: The United States and the Nuclear Test Ban Negotiations. Ann Arbor: University of Michigan Press, 1966, 538.

247. Klaw, Spencer. The New Brahmins: Scientific Life in America. New York: Morrow, 1968, xiv, 315.

248. Kornhauser, William. Scientists in Industry: Conflict and Accommodation. Berkeley: University of California Press, 1962, xii, 230.

249. Lapp, Ralph E. The New Priesthood. New York: Harper and Row, 1965, 244.

250. Layton, Edwin T. The Revolt of the Engineers, Cleveland, Ohio: Press of Case Western Reserve University, 1971, 286.

251. Lecht, Leonard A. Manpower Needs for National Goals in the 1970's. New York: Praeger, 1969, 183.

252. Lindveif, Earl W. Scientists in Government. Washington, D.C.: Public Affairs Press, 1960, 85.

253. Lynn, Kenneth S. and the Editors of Daedalus. The Professions in America. New York: Houghton, 1965, 273. Includes: "Aspects of the Professionalization of Science" by John J. Beer and W. David Lewis; and "The American Engineer" by C. Richard Soderberg.

254. Mattfield, Jacquelyn A. and Carol E. Van Aken. Women and the Scientific Professions: The M.I.T. Symposium on American Women in Science and Engineering. Cambridge, Massachusetts: M.I.T. Press, 1965, 272.

255. Michelmore, Peter. The Swift Years: The Robert Oppenheimer Story. New York: Dodd, Mead, 1969, 273.

256. Mottur, E. R. Conversion of Economic and Technical Resources: Economic Challenge--Social Opportunity. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1971, 201. (GWPS-Mon 8)

257. National Academy of Sciences. Scientific, Technical, and Related Societies of the United States. Ninth Edition. Washington, D.C.: National Academy of Sciences, 1971, 213. (ISBN 0-309-01860-9)

258. ________. Committee on Scientific and Technical Communication. Scientific and Technical Communication: A Pressing National Problem and Recommendations for Its Solution. Washington, D.C.: National Academy of Sciences, 1969, 322.

259. National Academy of Sciences-National Research Council. Scientific and Technical Societies of the U.S. and Canada. Seventh Edition. Washington, D.C.: National Academy of Sciences-National Research Council, 1961, 413, 54. (Publication No. 900)

260. National Science Foundation. American Science Manpower, 1968. Report of the National Register of Scientific and Technical Personnel. Washington, D.C.: U.S. Government Printing Office, 1969, 277. (NSF 69-38)

261. ________. Directory of Federal R&D Installations. Washington, D.C.: U.S. Government Printing Office, 1970, 1044.

262. National Science Foundation. Employment of Scientific and Technical Personnel in State Government Agencies. Report on a 1959 Survey. Washington, D. C.: U. S. Government Printing Office, 1961, 67. (NSF 61-17)

263. ________. Salaries and Selected Characteristics of U.S. Scientists, 1970. Reviews of Data on Science Resources. Washington, D.C.: U.S. Government Printing Office, 1970, 8. (NSF 70-50)

264. ________. Science and Engineering Doctorate Supply and Utilization, 1969-1980. Washington, D.C.: U.S. Government Printing Office, 1969, 33. (NSF 69-37)

265. ________. Science and Engineering Doctorate Supply and Utilization, 1969-1980. Washington, D.C.: U.S. Government Printing Office, 1971. (NSF 71-20)

266. ________. Scientific Activities of Independent Nonprofit Institutions, 1970. Report of a Survey of 1970 Employment and 1969 Expenditures. Washington, D.C.: U.S. Government Printing Office, 1971, 63.

267. ________. Scientific, Technical, and Health Personnel in the Federal Government, 1969. Washington, D.C.: U.S. Government Printing, Office, 1970, 40. (NSF 70-44)

268. ________. Unemployment Rate for Engineers, June-July, 1971. Science Resources Studies Highlights. Washington, D.C.: U.S. Government Printing Office, 1971, 4. (NSF 71-33)

269. ________. Unemployment Rates for Scientists, Spring 1971. Science Resources Studies Highlights. Washington, D.C.: U.S. Government Printing Office, 1971, 4. (NSF 71-26)

270. Nelson, Carnot E. and Donald K. Pollock, eds. Communication among Scientists and Engineers. Lexington, Massachusetts: Heath Lexington, 1970, 346.

271. Nelson, William R., ed. The Politics of Science: Readings in Science, Technology, and Government. London: Oxford University Press, 1968, 495.

272. Obler, Paul C. and Herman A. Estrin, eds. The New Scientist: Essays on the Methods and Values of Modern Science. Garden City, New York: Doubleday, 1962, 316.

273. Ornstein, Martha. The Role of Scientific Societies in the Seventeenth Century. Chicago: University of Chicago Press, 1929, xiv, 308.

274. Orth, Charles D., III, Joseph C. Bailey, and Francis W. Wolek. Administering Research and Development--The Behavior of Scientists and Engineers in Organizations. Homewood, Illinois: Richard D. Irwin, 1964, x, 585. A casebook, but note chapters 6-8.

275. Pelz, Donald C. and Frank M. Andrews. Scientists in Organizations: Productive Climates for Research and Development. New York: Wiley, 1966, 318.

276. Price, Derek J. de Solla. Little Science, Big Science. New York: Columbia University Press, 1963, 119.

277. Price, Don K. The Scientific Estate. Cambridge, Massachusetts: Harvard University Press, 1965, 323.

278. Rabi, Isidor I., Robert Serber, V.F. Weisskopf, A. Pais, and Glenn T. Seaborg. Oppenheimer. New York: Scribner's, 1969, 90.

279. Reid, Robert W. Tongues of Conscience: War and the Scientist's Dilemma. London: Constable, 1969, 352.

280. Rotblat, Joseph. Pugwash--The First Ten Years: History of the Conferences of Science and World Affairs. London: Heinemann, 1967, 244.

281. Royal Society of London. Emigration of Scientists from the United Kingdom. London: Royal Society of London, 1964, 32.

282. Schooler, Dean, Jr. Science, Scientists, and Public Policy. New York: Macmillan Free Press, 1971, 337.

283. Skolnikoff, Eugene B. Science, Technology, and American Foreign Policy. Cambridge, Massachusetts: M.I.T. Press, 1967, 330.

284. Snow, Charles P. Public Affairs. New York: Scribner's, 1971, 224.

285. Stern, Phillip M. The Oppenheimer Case: Security on Trial. New York: Harper and Row, 1969, 591.

286. Storer, Norman W. The Social System of Science. New York: Holt, Reinhart, and Winston, 1966, 180.

287. Strauss, Anselm L. and Lee Rainwater. The Professional Scientists: A Study of American Chemists. Chicago: Aldine, 1962, 282.

288. Strickland, Donald A. Scientists in Politics: The Atomic Scientists Movement, 1945-1956. Lafayette, Indiana: Purdue University Studies, 1968, 149.

289. United Nations Educational, Scientific, and Cultural Organization. Directory of International Scientific Organizations. Second Edition. Paris: UNESCO, 1953, 312.

290. U.S. Atomic Energy Commission. Universities, National Laboratories, and Man's Environment. Oak Ridge, Tennessee: Division of Technical Information, U.S. Atomic Energy Commission, 1969, 168. (CONF-690705)

291. U.S. Congress. House. Committee on Education and Labor. General Subcommittee on Education. National Science Research Data Processing and Information Retrieval System. Hearings before the Subcommittee to the 91st Congress, 1st Session, April, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 405.

292. ________. Committee on Foreign Affairs. Subcommittee on International Organizations and Movements. International Council of Scientific Unions. Hearing before the Subcommittee to the 89th Congress, 1st Session, June 7, 1965. Washington, D.C.: U.S. Government Printing Office, 1965, 40.

293. ________. Committee on Science and Astronautics. The Management of Information and Knowledge. Proceedings of the Eleventh Meeting of the Panel on Science and Technology before the Committee to the 91st Congress, 2nd Session, January, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 237. (No. 15, 27-29)

294. U.S. Congress. Senate. Committee on Commerce. Subcommittee on Oceanography. Federal Oceanic and Atmospheric Organization. Hearings before the Subcommittee to the 91st Congress, 1st and 2nd Sessions, December 17, 1969-May 4, 1970 (Two Parts). Washington, D.C.: U.S. Government Printing Office, 1970, 1286.

295. ________. Committee on Commerce. Subcommittee on Oceanography. Reorganization Plan No. 4 of 1970 to Create a National Oceanic and Atmospheric Administration in the Department of Commerce. Hearings before the Subcommittee to the 92nd Congress, 2nd Session, July 27, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 18.

296. ________. Committee on Government Operations. Reorganization Plan No. 4 of 1970, Providing for the Establishment of a National Oceanic and Atmospheric Administration in the Department of Commerce. Senate Report 91-1242 to accompany Senate Resolution 433, 91st Congress, 2nd Session, September 28, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 15.

297. ________. Committee on Public Works. The Case for National Environmental Laboratories. Report prepared by the Ad Hoc NEL Concept Committee, Oak Ridge National Laboratory for the Committee. Washington, D.C.: U.S. Government Printing Office, 1970, 40.

298. U.S. Department of Commerce. NOAA Photoessay No. 1: A New Agency. Rockville, Maryland: Office of Public Information, National Oceanic and Atmospheric Administration, 1970, 8.

299. U.S. Department of Labor. Bureau of Labor Statistics. Federal Spending and Scientists and Engineer Employment. Washington, D.C.: U.S. Government Printing Office, 1970, 46.

300. U.S. Federal Council for Science and Technology. Proceedings--First Symposium: Current Problems in the Management of Scientific Personnel, October 17-18, 1963. Washington, D.C.: U.S. Government Printing Office, 1964, 131.

301. ________. U.S. Civil Service Commission. Proceedings--Third Symposium: The Environment of the Federal Laboratory, December 7-8, 1964. Washington, D.C.: U.S. Government Printing Office, 1965, 125.

302. U.S. Library of Congress. Legislative Reference Service. Science Policy and Research Division. Interdisciplinary Research--An Exploration of Public Policy Issues. Prepared for the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, U.S. House of Representatives, 91st Congress, 2nd Session, by Genevieve J. Knezo. Washington, D.C.: U.S. Government Printing Office, 1970, 106.

303. Wakelin, J. H., Jr. The National Stake in Better Technical Information. Washington, D.C.: U.S. Department of Commerce, 1971, 9.

304. Wallia, C.S., ed. Toward Century 21: Technology, Society, and Human Values. New York: Basic Books, 1970, 318.

305. Walton, Richard E. The Impact of the Professional Engineering Unions--A Study of Collective Bargaining among Engineers and Scientists and Its Significance for Management. Cambridge, Massachusetts: Harvard University, Division of Research, Graduate School of Business Administration, 1961, xiii, 419. Biblio.

306. Watson, James D. The Double Helix: A Personal Account of the Discovery of the Structure of DNA. New York: Atheneum, 1968, 266.

307. Wolfle, Dael. The Uses of Talent. Princeton, New Jersey: Princeton University Press, 1971, 204.

308. Ziman, John M. Public Knowledge: The Social Dimension of Science. London: Cambridge University Press, 1966, 148.

LEADING QUESTIONS

1. Why is science as a profession sometimes compared to a priesthood? Is the analogy in any sense valid? What does it mean?

2. Are there discernible elements in scientific work that tend to cause scientists to react in predictable ways to social issues? For example, are there particular social attitudes or viewpoints associated with science or with particular sciences?

3. How do you explain recurrent surpluses and shortages among scientists and engineers? What policies would be required to avoid repetition of such occurrences?

4. What consequences follow from the naivete of certain prestigious scientists regarding mass social behavior and a paralleling naivete in society generally regarding the character and capacities of scientists?

5. Why has the employment of scientists in government occasioned so much study and concern? What have been the principal complaints of the government scientist against his employers? Of public officials against some scientists?

6. What changes, if any, in the education of scientists and technicians would improve the quality of their contributions to science and to society? If changes are indicated, how might they most effectively be implemented?

7. If scientists who leave scientific work for administrative or advisory responsibilities are still considered "scientists," why are science-trained physicians and engineers not considered scientists, even when they are actively using scientific knowledge and methods?

8. How important is the problem of communication among the science occupations and between them and other occupational groups? What, if anything, can be done to alleviate the difficulties?

9. What problems has the information explosion caused in scientific and technical fields? What have been some of the remedies, actual and proposed?

10. What has been the role of scientists in the formation of national policy? Should their participation increase in the formation of goals and priorities? What contributions are scientists making to international policies for science and technology?

TOPIC 05 SCIENCE, TECHNOLOGY, AND HIGHER EDUCATION

Man's knowledge of reality is both personal and social. The growth of civilization is measured by the accumulation and organization of knowledge. Contemporary man may have no greater intellect than did the man of Cro-Magnon. But he possesses an accumulating and transmissible culture that extends his knowledge far beyond direct personal experience.

The organization of knowledge into academic disciplines, or bodies of information and method called sciences, is artificial. The sciences are convenient ways of structuring knowledge, but the structures are constantly under stress as the substance and significance of knowledge change. A major task of higher education in the technoscientific age is the reorganization of knowledge. Two contrasting processes characterize the expansion of scientific knowledge. The first is specialization. Sciences such as chemistry and microbiology have been subdivided into ever more specific fields of specialization. The second is synthesis. Hybrid sciences, such as biophysics and geochemistry, form new specialties out of fusions between previously established sciences. And broadly inclusive synthesizing sciences or scientific concepts, such as ecology or general systems theory, move toward the integration of scientific knowledge and the systematic structuring of the unity of science.

The expansion and specialization of scientific knowledge created difficulties in the education of scientific workers and of citizens generally. For example, how much understanding of traditional culture, or of nonscientific concepts and values, is it desirable for scientific workers to possess? Particularly in a self-governing society, is it enough for scientists to know science--or should they know more to be effective as citizens or as fully developed human beings? And in a technoscientific society what do citizens need to know about science and technology? Can the great powers inherent in technoscientific knowledge be effectively controlled or responsibly used in a society in which the mass of the people does not comprehend the nature and implications of science or technology?

By the latter half of the 17th century, the power of science and technology to serve the interests of the state had begun to be perceived in European governments. Official patronage of science and technology began with the establishment of academies and, in the 19th century, was expressed in the founding of advanced schools of technology (e.g., les Grandes Ecoles in France) and by public financial support for faculties, institutes, and laboratories for scientific training and research. By mid-20th century, education for science and technology had become a major commitment in all technoscientifically advanced societies and was promoted and assisted by international agencies.

TOPIC 05 SCIENCE, TECHNOLOGY, AND HIGHER EDUCATION

Selected Basic Readings:

Ben-David, Joseph. "The Universities and the Growth of Science in Germany and the United States," Minerva, VII (Autumn and Winter, 1968), 1-35.

Bevan, William. "Science in the Universities in the Decade Ahead," American Scientist, LIX (November-December, 1971), 680-685.

Seitz, Frederick. "Science, the Universities, and Society," American Scientist, LVI (Autumn, 1968), 288-297.

Weiss, Paul. "Science in the University," Daedalus, XCIII (Fall, 1964), 118[illegible]-1218.

Wilson, John T. "A Dilemma of American Science and Higher Educational Policy: The Support of Individuals and Fields versus the Support of Universities," Minerva, IX (April, 1971), 171-196.

Supplementary and Substitute Readings:

Brown, Gordon S. "Can Universities Fulfill the Challenge of Relevance?" Technology Review, LXXIII (October-November, 1970), 25-31.

Ferdinand, Theodore N. "On the Obsolescence of Scientists and Engineers," American Scientist, LIV (March, 1966), 46-56.

Handler, Philip. "The Federal Government and the Scientific Community," Science, CLXXI (January 15, 1971), 144-151.

Kash, Don E. "Research and Development at the University," Science, CLX (June 21, 1968), 1313-1318.

Todd, Alexander R. "A Time to Think," Advancement of Science, XXVII (September, 1970), 1-6.

TOPICAL OUTLINE	REFERENCE KEY
I. The Curricula of Higher Education as Expressive of the State and Configuration of Knowledge	2, 14, 157, 175, 184, 186, 187, 204, 252
A. The "Sciences" as formalized organizations of knowledge	
1. Physical	19, 190
2. Biological	
3. Behavioral and social	20, 63
4. Interface areas, the "border" sciences	
B. Evolution of scientific and technical disciplines	13
1. Fission and fusion in the "house of science"	30
2. Emergence of technoscientific professional education	96, 184
a. Biomedicine	24, 52, 59, 101, 108, 134, 140
b. Agriculture	21
c. Engineering	5, 26, 83, 89, 125, 127
d. Social work	
e. Law enforcement	
f. Administration	
g. Education and training	
3. How interdisciplinary and multidisciplinary fields emerge	31, 41
C. Need for general scientific "literacy" and efforts to meet the need in the university curriculum	2, 66, 132, 136, 180, 231
D. The social content of technical education--the growing imperative for "social literacy" among scientists, physicians, and engineers	39, 46, 237

II. Relation of Basic Science to Applied Science and Technology in Higher Education	34, 186, 200
A. Science in the academic tradition	29, 37, 64, 176, 198, 231
1. Humanist objections to science and technology	63, 235
2. Scientist's aversion to tests of practicality	39, 46, 158
3. Role of science in general education	9, 63, 72, 152, 157
B. Public response to the need for advanced technoscientific education	78, 94, 227, 253
1. A European example--the great technical schools of France	
2. Some American responses	21, 205
a. Morrill Land Act	
b. Medical education	131
c. Sea Grant Program	243
d. Intergovernmental Personnel Act	
3. Technical Institutes	42, 47, 62, 84, 110, 200
a. Massachusetts Institute of Technology	
b. California Institute of Technology	
C. Problems of specialization; depth and breadth in scientific and technical education	73, 82, 93, 132, 161, 178, 189
1. Rapid obsolescence of information	57, 107, 143, 149
2. Over-specialization	30, 46, 158, 160
3. Identification of relevance	22, 39
4. Educating the whole person	8, 66, 69, 81, 106, 135, 152, 167
D. Application of science and technology to improving the educational process	155, 191, 224, 241, 248
1. Enlarging individualized conditions of learning	11, 18, 97, 224
2. Improving techniques and capabilities in the organization and management of higher education	133, 244, 245

3. Overcoming technical and informational obsolescence; the growth of mid-career education--a third level in higher education — 14, 57, 59, 107, 149, 163, 237

4. Recording and retrieval of information (Cf. Topic 04)

III. Interaction among the Disciplines in Higher Education--An Aspect of the Changing Configuration of Knowledge — 14, 25, 51, 56, 80, 148, 198

A. Influence of the "natural" sciences in the social and behavioral sciences — 3

1. Underdeveloped study of the biological basis of human behavior--effects upon anthropology, economics, and political science — 79, 201
2. Influence of physical science concepts and methods on biology and the social sciences--the relevance of quantification — 22, 157
3. Need for integrative concepts and more fruitful approaches to the study of social behavior — 37, 50, 65, 102, 178
4. Emergence of science policy and environmental studies as fields combining the natural and social sciences — 23, 32, 49, 53, 55, 85, 100, 128, 138, 202, 21[illegible], 229, 236, 252

B. Scientific concepts and methods in the arts and humanities (a continuation of Topic 03) — 119, 120, 235

1. Physics and music-theory-instrumentation accoustics — 142
2. Scientific technology in the graphic and plastic arts
3. Scientific technology in archaeology and history

4. Scientific methods in literary and textual criticism and in linguistics

C. Influence of the sciences in relationships among professional disciplines--their manifestation in teaching and research — 184, 198, 234, 237

1. Law and medicine (forensic medicine)
2. Physiology, psychology, and engineering (human engineering, bio-instrumentation) — 201
3. Pharmacology, chemistry, and agriculture (nutrition and toxicology)
4. Criminology and justice (scientific analysis in prevention and detection of crime)

IV. Broader Impact of National Policies on Higher Education for Science and Technology — 17, 18, 31, 36, 60, 97, 99, 121, 150, 156, 165, 166, 175, 181, 192, 196, 210, 226, 256

A. Effect of the growing relationship between higher education and economic growth — 12, 77, 92, 103, 111, 133, 193

1. Amount and substantive allocation of public funds — 58, 129, 171, 177, 194, 208, 209, 215, 217, 218, 219, 228
2. Location of universities and research centers — 6, 15, 44, 204
3. Closer ties between high-technology industries and academia — 105, 144, 256
4. Growing investment of national government in higher education, especially through aid of scientific research — 7, 41, 68, 71, 86, 90, 94, 114, 122, 123, 151, 170, 206, 213, 220, 238

5. Increasing cost of higher education and the changing basis of financial support — 10, 16, 40, 43, 88, 104, 111, 112, 124, 141, 147, 179

B. Science and technological education in relation to national programs and missions — 29, 70, 199, 203, 230

1. Effects of changes in government policy on the institutions of higher education--e.g., draft laws, research cut-backs, training grants — 54, 75, 116, 117, 137, 145, 154, 159, 168, 221, 223, 232, 249

2. Links between mission agencies, national laboratories, and universities — 35, 87, 95, 139, 174, 195, 212

3. Defense-oriented research on campus--a changing picture — 38, 45, 67, 130, 146, 169, 173, 182

4. Problem-oriented research relating to national needs--the RANN Program of the National Science Foundation — 118, 126, 172

5. Special problems of "dangerous knowledge," e.g., in psychology, genetics, pharmacology, and physical science (developed extensively in Topics 16-20) — 28, 38, 64, 182

BIBLIOGRAPHY

General References: Articles

1. Adams, Thomas W. and Thomas P. Murphy. "NASA's University Research Programs: Dilemmas and Problems on the Government-Academic Interface," Public Administration Review, XXVII (March, 1967), 10-17.

2. Adrian, Edgar D. "The Place of Science in Universities Past and Present," Nature, CLXXXIII (June 20, 1959), 1706-1709.

3. ________. "Science and Human Nature," Advancement of Science, XI (September, 1954), 121-128.

4. Allison, David. "The Affluent Consultants," International Science and Technology, Number 10 (October, 1962), 50-54.

5. ________. "Educating the Engineer," International Science and Technology, Number 18 (June, 1963), 26-38.

6. ________. "The University and Regional Prosperity," International Science and Technology, Number 40 (April, 1965), 22-31.

7. Arnold, Christian K. "Federal Support of Basic Research in Institutions of Higher Learning: A Critique," Educational Record, XLV (Spring, 1964), 199-203.

8. Ashby, Eric. "Humanities for the Technologist," Nature, CLXXX (September 28, 1957), 624-627.

9. ________. "Technological Humanism," Impact of Science on Society, VIII (Number 1, 1958), 45-58.

10. Ashworth, Kenneth H. "Coordinating the Federal Role in Higher Education," Educational Record, XLIX (Summer, 1968), 316-324.

11. Atkinson, Richard C. and Harlalee A. Wilson. "Computer-Assisted Instruction," Science, CLXII (October 4, 1968), 73-77.

12. Barry, David G. "Universities as Innovators," Industrial Research, VIII (April, 1966), 58-60; 63-65.

13. Ben-David, Joseph. "The Universities and the Growth of Science in Germany and the United States," Minerva, VII (Autumn and Winter, 1968), 1-35.

14. Berkner, Lloyd V. "Advanced Education for a New Age," in his The Scientific Age: The Impact of Science on Society. New Haven, Connecticut: Yale University Press, 1964, 23-52.

15. ________. "Graduate Centers: Key to Innovation," Industrial Research, VI (April, 1964), 66-74.

16. Betz, Frederick and Carlos Kruytbosch. "Sponsored Research and University Budgets: A Case Study in American University Government," Minerva, VIII (October, 1970), 492-519.

17. Bevan, William. "Science in the Universities in the Decade Ahead," American Scientist, LIX (November-December, 1971), 680-685.

18. Boocock, Sarane S. "Technology and Education Structure," Educational Technology, IX (January, 1969), 19-21.

19. Booker, Henry G. "Academic Organization in Physical Science," Science, CXLVI (October 2, 1964), 35-37.

20. Boulding, Kenneth E. "Dare We Take the Social Sciences Seriously?" American Behavioral Scientist, X (June, 1967), 12-16.

21. Bowden, Bertram V. "The Lesson of the 'Cow Colleges'," New Scientist, XVI (December 6, 1962), 574-575.

22. Bowers, R. "Some Views on Physics and Society," American Scientist, LVIII (November-December, 1970), 607-611.

23. Brademas, John. "How Much Longer Should Environmental Education Wait?" Congressional Record, CXVII (July 1, 1971), E6867-E6868.

24. Bradley, Stanley E. "Medical Education and Medical Research--An Interaction," New England Journal of Medicine, CCLXIX (December 12, 1963), 1292-1296.

25. Brown, Gordon S. "Can Universities Fulfill the Challenge of Relevance?" Technology Review, LXXIII (October-November, 1970), 25-31.

26. Brown, Gordon S. "New Horizons in Engineering Education," Daedalus, XCI (Spring, 1962), 341-36

27. Brudner, Harvey J. "Computer-Managed Instruction," Science, CLXII (November 29, 1968), 970-976.

28. Bulletin of the Atomic Scientists. "Classified Research in the University," Bulletin of the Atomic Scientists, XXIII (October, 1967), 45-46.

29. ________. "Student Attitudes on Science," Bulletin of the Atomic Scientists, XXVII (May, 1971), 31-35.

30. Calder, Ritchie. "The Fragmentation of Science," Advancement of Science, XII (December, 1955), 328-338.

31. Caldwell, Lynton K. "Managing the Scientific Super-Culture: The Task of Educational Preparation," Public Administration Review, XXVII (June, 1967), 128-133.

32. ________. "Some Problems of Curriculum Development," in Science and Public Policy in the American University, ed. by Lynton K. Caldwell. Bloomington: Indiana University Program in the Public Administration of Science and Technology, 1969, 55.

33. Carlson, Anton J. "Science, Education, and the Future of Man," Scientific Monthly, LXV (December, 1947), 498-502.

34. Carroll, James D. "The Process Values of University Research," Science, CLVIII (November 24, 1967), 1019-1024.

35. Carter, Luther J. "Lunar Science Institute: Link between NASA and Academe," Science, CLXIII (March 21, 1969), 1311-1313.

36. Cartter, Allan M. "All Sail and No Anchor," American Scientist, LIX (March-April, 1971), 178-182.

37. Cassidy, Harold G. "The Problem of the Sciences and the Humanities: A Diagnosis and a Prescription," American Scientist, XLVIII (September, 1960), 383-398.

38. Coburn, Judith. "University Contractors Cut Ties with CRESS, HumRRO, Army's Two Main Centers of Social, Behavioral Research," Science, CLXIV (May 30, 1969), 1039-1041.

39. Conant, James B. "History in the Education of Scientists," American Scientist, XLVIII (December, 1960), 528-543.

40. Consolazio, William V. "The Fiscal Dilemma of Academic Science," Bulletin of the Atomic Scientists, XXI (February, 1965), 15-18.

41. Cunningham, D. E. "Federal Support and Stimulation of Interdisciplinary Research in Universities," Miami University Research 69-142, NASA, N70-21072 (October, 1969), 73.

42. Curtis, Roger W. "The Max Planck Institutes," International Science and Technology, Number 19 (July, 1963), 42-47.

43. Daddario, Emilio Q. "Academic Science and the Federal Government," Science, CLXII (December 13, 1968), 1249-1251.

44. Danilov, Victor J. "New Centers of Excellence," Industrial Research, VII (April, 1965), 36-49.

45. ______. "Turmoil on the Campus," Industrial Research, X (April, 1968), 70-78.

46. De Broglie, Louis. "Is Scientific Training Enough for a Man?" Impact of Science on Society, I (October-December, 1950), 106-107.

47. De Witt, Nicholas. "Soviet Education for Science and Technological Supremacy," in Peace and War in the Modern Age, ed. by Frank R. Barnett, William C. Mott, and John Neff. Garden City, New York: Doubleday, 1965, 271-282.

48. Douglass, William A. "How to Stop the Brain Drain," New Scientist, XXXIV (April 6, 1967), 39-41.

49. Dror, Yehezkel, ed. "Universities and the Teaching of Policy Sciences--Part 1," Policy Sciences, I (December, 1970), 40?-482.

50. Duncan, W. Jack, W. T. Edwards, and J. Wayne Flynt. "An Experiment in Large Group Interdisciplinary Investigations Into Contemporary Social Issues," Social Science, XLVI (October, 1971), 216-222.

51. Eisley, Loren. "Illusion of Two Cultures," American Scholar, XXXIII (Summer, 1964), 387-399.

52. Elvehjem, Conrad A. "Research and Training," Journal of the American Medical Association, CLXX (May 23, 1959), 428-432.

53. Ericson, R. F. "The Policy Analysis Role of the Contemporary University," Policy Sciences, I (December, 1970), 429-442.

54. Fagin, B. and T. Marshall. "Graduate Science: A Tale of Two Universities," Scientific Research, IV (September 15, 1969), 26-27.

55. Falk, Charles E. "Science and Public Policy Activities in Universities," Bulletin of the Atomic Scientists, XXIV (June, 1968), 50-52.

56. Fallers, Lloyd. "C. P. Snow and the Third Culture," Bulletin of the Atomic Scientists, XVII (October, 1961), 306-310.

57. Ferdinand, Theodore N. "On the Obsolescence of Scientists and Engineers," American Scientist, LIV (March, 1966), 46-56.

58. Gallant, Jonathan A. and John W. Prothero. "Weight-Watching at the University: The Consequences of Growth," Science, CLXXV (January 28, 1972), 381-388.

59. Gardner, John W. "The Government, the Universities, and Biomedical Research," Science, CLIII (September 30, 1966), 1601-1603.

60. Gideonse, Hendrik D. "Research, Development, and the Improvement of Education," Science, CLXII (November 1, 1968), 541-545.

61. Gillis, J. "The Weizmann Institute," International Science and Technology, Number 56 (August, 1966), 61-70.

62. Glass, H. Bentley. "The Japanese Science Education Centers," Science, CLIV (October 14, 1966), 221-228.

63. ________. "Liberal Education in a Scientific Age," Bulletin of the Atomic Scientists, XIV (November, 1958), 346-353.

64. Goddard, David R. and Linda C. Koons. "Intellectual Freedom and the University," Science, CLXXIII (August 13, 1971), 607-610.

65. Goodwin, Leonard. "On Making Social Research Relevant to Public Policy and National Problem Solving," American Psychologist, XXVI (May, 1971), 431-442.

66. Green, Robert B. "Education in the Sciences," Scientific Monthly, LXXIX (July, 1954), 40-44.

67. Greenberg, Daniel S. "IDA: University-Sponsored Center Hit Hard by Assaults on Campus," Science, CLX (May 17, 1968), 744-748.

68. Handler, Philip. "The Federal Government and the Scientific Community," Science, CLXXI (January 15, 1971), 144-151.

69. Harnwell, Gaylord P. "Education and the Generation of New Ideas," Physics Today, XV (March, 1962), 34-40.

70. Harris, W. J. "On the Convergence of Engineering and Society," Technology Review, LXXII (July-August, 1970), 39-41.

71. Hauser, Ernst A. "The Importance of Science in American Education," Science, CXIII (June 8, 1957), 643-646.

72. Haworth, Leland J. "Government Support of Academic Science," Educational Record, XLVII (Spring, 1966), 127-137.

73. Hildebrand, Joel H. "To Tell or Hear Some New Thing," American Scientist, LI (March, 1963), 1-11.

74. Hollomon, J. Herbert. "Modern Engineering and Society: The Marriage between Technical Ability and Social Need," Chemical and Engineering News, XLII (June 29, 1964), 66-71.

75. Holloway, B. "Great Expectations?" New Scientist and Science Journal, L (May 20, 1971), 442-444.

76. Hornig, Donald I. "Universities and Federal Science Policies," Science, CL (November 12, 1965), 847-851.

77. Horowitz, Irving L. "The Academy and the Polity: Interaction between Social Scientists and Federal Administrators," Journal of Applied Behavioral Science, V (July-September, 1969), 309-335.

78. Hudson, F. Lyth and R. H. Peters. "The Case for University Courses in Technology," New Scientist, VII (May 26, 1960), 1339-1340.

79. Huxley, Julian S. "Education and Humanism," in his Essays of a Humanist. New York: Harper and Row, 1964, 116-146.

80. Ingman, Stan. "A New Faith: Interdisciplinarianism," Social Science and Medicine, V (October, 1971), 491-494.

81. Insold, Christopher. "Education of a Scientist," Nature, CXCVI (December 15, 1962), 1030-1034.

82. Jevons, F. R. "Education, Science, and Society," Advancement of Science, XXVII (March, 1971), 227-232.

83. Johnstone, R. Edgeworth. "Some Thought on Engineering Education," Nature, CXCIII (February 17, 1962), 618-622.

84. Juszli, Frank L. "The Two-Year Technical Institute," Research Management, VIII (September, 1965), 293-296.

85. Kash, Don E. "Forces Affecting Science Policy," Bulletin of the Atomic Scientists, XXV (April, 1969), 10-15.

86. ________. "Research and Development at the University," Science, CLX (June 21, 1968), 1313-1318.

87. Keenan, Boyd R. "High Energy Administration: Big Science Model for the Future," Public Administration Review, XXVIII (May-June, 1968), 250-255.

88. Kerr, Clark. "The Realities of the Federal Grant University," Educational Record, XLIV (April, 1963), 165-167.

89. Kestin, Joseph. "Reflections on the Teaching of Engineering at a University," American Scientist, LI (December, 1963), 437-445.

90. Kidd, Charles V. "American Universities and Federal Research," in The Sociology of Science, ed. by Bernard Barber and Walter Hirsch. New York: Free Press of Glencoe, 1962, 394-416.

91. ________. "Private Giving and Federal Aid for Medical Education," Journal of the American Medical Association, CLXXXVIII (April 20, 1964), 295-298.

92. Killian, James R., Jr. "University Research and National Priorities," Technology Review, LXXII (July-August, 1970), 23-25.

93. Kirkman, A. J. "Turning Scientists into Free Thinkers," Nature, CCVI (June 26, 1965), 1293-1295.

94. Kloss, G. "The Growth of Federal Power in the West German University System," Minerva, IX (October, 1971), 510-527.

95. Kolstad, George A. "National Laboratories, Universities, and the AEC," Physics Today, XIX (April, 1966), 45-48.

96. Krebs, Hans A. "The Making of a Scientist," Nature, CCXV (September 30, 1967), 1441-1445.

97. Kurland, Norman D. "The Impact of Technology on Education," Educational Technology, VIII (October 30, 1968), 12-15.

98. Ladd, Everett C. "American University Teachers and Opposition to the Vietnam War," Minerva, VIII (October, 1970), 542-556.

99. Lakoff, Sanford A. "The Nth Culture Problem," Bulletin of the Atomic Scientists, XX (May, 1964), 21-23.

100. LaPorte, T. "Science, Technology, and Public Affairs at the University of California, Berkeley," SPPSG Newsletter, II (June-July, 1971), 10-12.

101. Leaf, Alexander. "Government, Medical Research, and Education," Science, CLIX (February 9, 1968), 604-607.

102. Lecuyer, Bernard-Pierre. "Contribution of the Social Sciences to the Guidance of National Policy," International Social Science Journal, XXII (1970), 264-300.

103. Lindveit, Earl W. "Science, Education, and Politics," Educational Record, XLV (Winter, 1964), 41-48.

104. Long, Franklin A. "Support of Scientific Research and Education in Our Universities," Science, CLXIII (March 7, 1969), 1037-1040.

105. Mahar, James F. and Dean C. Codding. "Academic Spinoffs," Industrial Research, VII (April, 1965), 62-71.

106. Marshall, W. R. "Social Directions of Engineering," Chemical Engineering Progress, LXVII (January, 1971), 11-16.

107. Martin, Thomas L., Jr. "GENESYS: Florida's Weapon against Technological Obsolescence," Research Management, VIII (November, 1965), 359-368.

108. Meyers, Russell. "A Critical Look at Medical Education in the United States with Comments on the Role of the 'Specialty Boards'," Perspectives in Biology and Medicine, I (Autumn, 1957), 48-68.

109. Miller, C. Arden. "A Critique of External Forces in Medical Education," Journal of the American Medical Association, CXCII (June 7, 1965), 145-149.

110. Mooney, William T. "The Training and Use of Technicians in Industrial Research: The Two-Year College Program in California," Research Management, VII (November, 1965), 387-395.

111. Morse, John F. "The Federal Government and Higher Education: General and Specific Concerns in the Years Ahead," Educational Record, XLVII (Fall, 1966), 429-438.

112. Muirhead, Peter P. "The New Pattern of Federal Aid to Higher Education," Educational Record, L (Spring, 1969), 171-176.

113. Munster, Joe H., Jr. "A Second Look at Government-Supported Research," Educational Record, XLVI (Spring, 1965), 149-157.

114. Munster, Joe H., Jr. and Justin C. Smith. "Savants, Sandwiches, and Space Suits," Science, CXLV (September 18, 1965), 1276-1281.

115. Murray, Keith. "Technology in the Universities," Nature, CXCVI (November 24, 1962), 710-714.

116. Muskie, Edmund S. "The Crisis in Academic Research," Congressional Record, CXVII (August 6, 1971), S13454-S13456.

117. Nature. "Are Graduate Students Worth Keeping?" Nature, CCXXV (March 14, 1970), 985-986.

118. ________. "RANN Cut Down to Size," Nature, CCXXXI (May 7, 1971), 8-9.

119. Negri, Numa C. "Art contra Science," Impact of Science on Society, XII (Number 1, 1962), 61-80.

120. Nicholson, Marjorie H. "Two Voices: Science and Literature," American Scientist, LI (December, 1963), 454-462.

121. OECD Observer. "Policy Implications of the Growth in Higher Education," OECD Observer, L (February, 1971), 13-18.

122. Orlans, Harold. "Academic Research and a Ridiculous Hungarian," Educational Record, XLIX (Summer, 1968), 245-249.

123. ________. "Developments in Federal Policy toward University Research," Science, CLV (February 10, 1967), 665-668.

124. Page, Howard E. "University Science Development One Hundred Million Dollars Later," Educational Record, XLIX (Summer, 1968), 250-256.

125. Park, Ford. "Tommorow's Engineer," International Science and Technology, Number 72 (December, 1967), 20-34.

126. Peter, W. G., III. "McElroy Explains NSF Budget Stand," BioScience, XXI (July 15, 1971), 775-777.

127. Pierce, John R. "What Are We Doing to Engineering?" Science, CXLIX (July 23, 1965), 397-399.

128. Policy Sciences. "Universities and the Teaching of Policy Sciences--Part II," Policy Sciences, II (March, 1971), 1-85.

129. Price, Don K. "Federal Money and University Research," Science, CLXI (January 21, 1966), 285-290.

130. Price, William J. "A Military Role in Basic Research?" Scientific Research, III (March 4, 1968), 25-27.

131. Pyrwes, Moshe. "The Balance of Research, Teaching, and Service in Medical Education," Minerva, IX (October, 1971), 451-471.

132. Rabi, Isidor I. "A Matter of Opinion: Are Scientists Becoming Nothing More Than High-Grade Technicians?" Scientific Research, II (September, 1967), 62-63.

133. Randall, Ronald and Charles Blaschke. "Educational Technology: Economics, Management, and Public Policy," Educational Technology, VIII (June 30, 1968), 5-13.

134. Rappleye, Willard C. "Medical Schools and the Federal Government," Journal of the American Medical Association, CLXXX (June 2, 1962), 714-717.

135. Ratcliffe, John A. "Science as Part of a General Education," New Scientist, II (July 4, 1957), 9-10.

136. Reif, Frederick. "Science Education for Nonscience Students," Science, CLXIV (May 30, 1969), 1032-1037.

137. Reinhold, Robert. "A Depression for Science?" Bulletin of the Atomic Scientists, XXIV (October, 1968), 4-8.

138. Ritterbush, Philip C. "Environmental Studies: The Search for an Institutional Form," Minerva, IX (October, 1971), 493-509.

139. ________. "Research Training in Governmental Laboratories in the United States," Minerva, IV (Winter, 1966), 186-201.

140. Romano, John. "Comparative Observations of Medical Education," Journal of the American Medical Association, CLXXVIII (November 18, 1961), 741-747.

141. Rosenstock, Herbert B. "Who Should Support Scholarly Research?" Bulletin of the Atomic Scientists, XXIV (January, 1968), 60-62.

142. Saunders, Frederick A. "Physics and Music," Scientific American, CLXXIX (July, 1948), 32-41.

143. Sayles, D. C. "Professional Obsolescence and This Rapidly Expanding Technological Era," Nature, CCVII (September 4, 1965), 1028-1030.

144. Schwitter, J. P. "Universities as Research Park Developers," Industrial Research, VII (April, 1965), 73-78.

145. Scientific Research. "NSF Spending Limit Disrupts Research," Scientific Research, III (October 28, 1968), 17-18.

146. Scientific Research. "Project Themis--Where Does It Stand?" Scientific Research, III (April 29, 1968), 27-28; 31-32.

147. Seaborg, Glenn T. "Government-University Partnership in Graduate Education," Educational Record, L (Spring, 1969), 177-185.

148. ________. "Science and the Humanities: A New Level of Symbiosis," Science, CXLIV (June 5, 1964), 1199-1203.

149. Siefert, William W. "The Prevention and Cure of Obsolescence in Scientific and Technical Personnel," Research Management, VII (March, 1964), 143-154.

150. Seitz, Frederick. "Science, the Universities, and Society," American Scientist, LVI (Autumn, 1968), 288-297.

151. Shannon, James A. "Thoughts on the Relationships between Science and Federal Programs," Educational Record, XLVIII (Summer, 1967), 214-223.

152. Sinnott, Edmund W. "Science and the Whole Man," American Scientist, XXXVI (January, 1945), 127-138.

153. Skinner, B. F. "Teaching Science in High School--What Is Wrong?" Science, CLIX (February 16, 1968), 704-710.

154. Small, William E. "A Crisis within a Crisis," Scientific Research, III (June 24, 1968), 19-20; 23-25.

155. Smith, Delbert D. "Educational Satellite Telecommunication: The Challenge of a New Technology," Bulletin of the Atomic Scientists, XXVII (April, 1971), 14-18.

156. Snow, Joel A. "Science and the Human Condition--An Introduction," Bulletin of the Atomic Scientists, XXIV (October, 1968), 24-25.

157. Suits, C. Guy. "Education and Science," American Scientist, XLVII (March, 1959), 60-67.

158. Taylor, James. "Chemistry Is Not Enough, or the Increasing Scope of Scientists' Work in Industry," Advancement of Science, XVII (September, 1960), 197-206.

159. Teter, D. P. "Higher Education: Funds Rise While Basic Changes Are Debated," Science, CLXXIII (July 23, 1971), 309-311.

160. Thirring, Hans. "The Step from Knowledge to Wisdom," American Scientist, XLIV (October, 1956), 445-456.

161. Tilson, Seymour. "Educating the Scientist," International Science and Technology, Number 39 (March, 1965), 46-53.

162. Todd, Alexander R. "A Time to Think," Advancement of Science, XXVII (September, 1970), 1-6.

163. Torpey, William G. "Company Investment in Continuing Education for Engineers," Educational Record, XLV (Fall, 1964), 408-413.

164. ________. "Federal Government Investment in Continuing Education for Engineers," Educational Record, XLVI (Fall, 1965), 412-415.

165. Trachtman, Leon F. "Is Research Interfering with Teaching?" Industrial Research, VI (April, 1964), 58-65.

166. Vallance, Theodore R. "The Government-University Relation to Social Science: A Review of Some Issues," American Behavioral Scientist, X (June, 1967), 28-32.

167. Van Norman, Richard W. "Undergraduate Training in Experimental Research," AIBS Bulletin (BioScience), VIII (April, 1958), 18-20.

168. Vetter, Betty M. "The Draft and Its Consequences," Scientific Research, III (September 2, 1968), 38-40; 42.

169. Walsh, John. "Confrontation at Stanford: Exit Classified Research," Science, CLXIV (May 2, 1969), 534-537.

170. ________. "Congress: Subcommittee Surveys Effect of Federally Supported Research on Higher Education," Science, CXLIX (July 2, 1965), 42-44.

171. ________. "Higher Education: Will Federal Aid Favor Students or Institutions?" Science, CLXXI (March 26, 1971), 1219-1221.

172. ________. "National Science Foundation: Managing Applied Research," Science, CLXXV (February 11, 1972), 611-614.

173. ________. "Stanford Research Institute: Campus Turmoil Spurs Transition," Science, CLXIV (May 23, 1969), 933-936.

174. Weinberg, Alvin M. "The Federal Laboratories and Science Education," Science, CXXXVI (April 6, 1962), 27-30.

175. Weiner, Charles. "Science and Higher Education," in Science and Society in the United States, ed. by David D. Van Tassell and Michael G. Hall. Homewood, Illinois: Dorsey Press, 1966, 163-189.

176. Weiss, Paul. "Science in the University," Daedalus, XCIII (Fall, 1964), 1184-1218.

177. Wilson, John T. "A Dilemma of American Science and Higher Educational Policy: The Support of Individuals and Fields versus the Support of Universities," Minerva, IX (April, 1971), 171-196.

178. Winthrop, Henry. "Needed Reconstruction in Education for a Cybernating Society," Educational Record, XLVI (Fall, 1965), 400-411.

179. Wolfle, Dael. "The Support of Science in the U.S.," Scientific American, CCXIII (July, 1965), 19-25.

180. Woodford, F. Peter. "Sounder Thinking through Clearer Writing," Science, CLVI (May 12, 1967), 743-745.

181. York, C. M. "Steps toward a National Policy for Academic Science," Science, CLXXII (May 14, 1971), 643-648.

General References: Books

182. Allen, Jonathan, ed. March 4: Scientists, Students, and Society. Cambridge, Massachusetts: M. I. T. Press, 1970, 177.

183. American Assembly. The Federal Government and Higher Education. Ed. by Douglas McKnight. Englewood Cliffs, New Jersey: Prentice-Hall, 1960, 205.

184. Ashby, Eric. Technology and the Academics: An Essay on the Universities and the Scientific Revolution. New York: Macmillan, 1958, vi, 117.

185. Ben-David, Joseph. Fundamental Research and the Universities: Some Comments on International Differences. Paris: Organization for Economic Cooperation and Development, 1968.

186. Blanshard, Brand, ed. Education in the Age of Science. New York: Basic Books, 1959, 302.

187. Bowden, Lord, Leo Goldberg, and Roger Gaudry. Science and the University. New York: St. Martin's Press, 1967, 104.

188. Brickman, William H. and Stanley Lehrer, eds. Automation, Education, and Human Values. New York: School and Society Books, Division of Society for the Advancement of Education, 1966, 419.

189. British Association for the Advancement of Science. Leverhulme Study Group. The Complete Scientists: An Enquiry into the Problem of Achieving Breadth in the Education at School and University of Scientists, Engineers, and other Technologists. New York: Oxford University Press, 1961, 162.

190. Brown, Sanborn C, and Norman Clarke, eds. The Education of a Physicist. Cambridge, Massachusetts: M.I.T. Press, 1966, 183.

191. Chorafas, D. N. The Knowledge Revolution. London: Allen and Unwin, 1968, 142.

192. Consolazio, William V. The Dynamics of Academic Science. Washington, D.C.: National Science Foundation, 1967, 190.

193. Dedijer, Stevan and L. Svennington, eds. Brain Drain and Brain Gain: A Bibliography on Migration of Scientists, Engineers, Doctors, and Students. Lund, Sweden: Research Policy Program, 1967, 48.

194. Drew, David. On the Allocation of Federal Funds for Science Education: A Case Study of the NSF College Science Improvement Program. Washington, D.C.: American Council on Education, 1970, 44.

195. Federal Council for Science and Technology. Education and Federal Laboratory-University Relationships. Proceedings of a Symposium, October 29-31, 1968. Washington, D.C.: Federal Council for Science and Technology and American Council on Education, 1969, 251.

196. Folger, John K., Helen S. Astin, and Alan E. Bayer. Human Resources and Higher Education. Staff Report of the Commission on Human Resources and Advanced Education. New York: Russell Sage Foundation, 1970, 480.

197. Gardner, John W. No Easy Victories. New York: Harper and Row, 1968, 177.

198. Glass, H. Bentley. Science and Liberal Education. Baton Rouge: Louisiana State University Press, 1959, x, 115.

199. ________. The Timely and the Timeless: The Interrelationships of Science, Education, and Society. New York: Basic Books, 1970, 99.

200. Graney, Maurice R. The Technical Institute. New York: Center for Applied Research in Education, 1964, x, 118. Biblio.

201. Grobman, A. B., ed. Social Implications of Biological Education. Princeton, New Jersey: Darwin Press, 1971, 134.

202. Harvard University Program on Technology and Society. Sixth Annual Report, 1969-1970. Cambridge, Massachusetts: Harvard University Press, 1971, 103.

203. Jevons, F. R. The Teaching of Science: Education, Science, and Society. London: Allen and Unwin, 1969, 208.

204. Keenan, Boyd R., ed. Science and the University. New York: Columbia University Press, 1966, 219.

205. Kellogg, Charles E. and David C. Knapp. The College of Agriculture: Science in the Public Service. New York: McGraw-Hill, 1966, 237.

206. Kidd, Charles V. American Universities and Federal Research. Cambridge, Massachusetts: Harvard University Press, 1959, 272.

207. Machlup, Fritz. The Production and Distribution of Knowledge in the United States. Princeton, New Jersey: Princeton University Press, 1962, xix, 416.

208. Marsh, Paul E. and Ross A. Gortner. Federal Aid to Science Education: Two Programs. Syracuse, New York: Syracuse University Press, 1963, xiii, 97. (The Economics and Politics of Public Education, No. 6)

209. National Academy of Sciences - National Research Council. Committee on Science and Public Policy. Federal Support of Basic Research in Institutions of Higher Learning. Washington, D.C.: National Academy of Sciences, National Research Council, 1964, 98. (Pub. 1185)

210. National Academy of Sciences. Science, Government, and the Universities. Seattle and London: University of Washington Press, 1966, 116.

211. ________. University Research and Patent Policies, Practices, and Procedures. By Archie M. Palmer. Washington, D.C.: National Academy of Sciences - National Research Council, 1962, 291. (Pub. 999)

212. National Aeronautics and Space Administration. A Study of NASA University Programs. Prepared by the Task Force to Assess NASA University Programs. Washington, D.C.: National Aeronautics and Space Administration, Office of Technology Utilization, 1968, 79. (NASA SP-185)

213. National Research Council. The Invisible University: Postdoctoral Education in the United States. Washington, D.C.: National Academy of Sciences, 1969, 312.

214. ________. Summary Report 1970: Doctorate Recipients from United States Universities. National Research Council Report OSP-MS-4. Washington, D.C.: National Research Council, 1971, 9.

215. National Science Foundation. The Dynamics of Academic Science: A Degree Profile of Academic Science and Technology and the Contributions of Federal Funds for Academic Science to Universities and Colleges. Washington, D.C.: National Science Foundation, 1967, 190. (NSF 67-6)

216. ________. Environmental Science--Challenge for the Seventies. Third Report of the National Science Board. Washington, D.C.: U.S. Government Printing Office, 1971, 50.

217. ________. Federal Funds for Academic Science, Fiscal Year 1969. Washington, D. C.: U. S. Government Printing Office, 1971, 80. (NSF 71-7)

218. ________. Federal Support of Universities and Colleges, Fiscal Year 1970. Science Resources Studies Highlights. Washington, D. C.: National Science Foundation, 1971, 4.

219. ________. Federal Support to Universities, Colleges and Selected Non-Profit Institutions, Fiscal Year 1969: A Report to the President and Congress. Washington, D. C.: U. S. Government Printing Office, 1971, 175. (NSF 70-27)

220. National Science Foundation. Graduate Student Support and Manpower Resources in Graduate Science Education, Fall 1969. Surveys of Science Resources Series. Washington, D.C.: U.S. Government Printing Office, 1970, 84. (NSF 70-40)

221. ________. Impact of Changes in Federal Science Funding Patterns on Academic Institutions, 1968-1970. Washington, D.C.: U.S. Government Printing Office, 1970, 76. (NSF 70-48)

222. ________. Resources for Scientific Activities at Universities and Colleges, 1969. Washington, D.C.: U. S. Government Printing Office, 1970, 152. (NSF 70-16)

223. ________. Toward a Public Policy for Graduate Education in the Sciences. First Report of the National Science Board. Washington, D.C.: National Science Foundation, 1969, 63. (NSB 69-1)

224. Oettinger, Anthony G., with the collaboration of Sema Marks. Run, Computer, Run: The Mythology of Educational Innovation. Cambridge, Massachusetts: Harvard University Press, 1969, 302.

225. Organization for Economic Cooperation and Development. Reviews of National Policies for Education. Paris: OECD. Three Volumes: Italy, 1969, 280; Sweden, 1969, 70; and Netherlands, 1970, 76.

226. ________. Reviews of National Policies for Education: United States. Paris: OECD, 1971, 432.

227. ________. Directorate for Scientific Affairs. Reviews of National Policies for Science and Education: Higher Education and the Demand for Scientific Manpower in the United States. Paris: OECD, 1963, 102.

228. Orlans, Harold. The Effects of Federal Programs on Higher Education: A Study of Thirty-Six Universities and Colleges. Washington, D. C.: Brookings Institution, 1962, 361.

229. ________, ed. Science Policy and the University. Washington, D. C.: Brookings Institution, 1968, 352.

230. Ridgeway, James. The Closed Corporation: American Universities in Crisis. New York: Random House, 1968, 273.

231. Rouçek, Joseph S., ed. The Challenge of Science Education. New York: Philosophical Library, 1959, 491. Biblio.

232. Scientific Manpower: A Dilemma for Graduate Education. Summary of discussions at a May, 1970, Symposium on The Supply, Need, and Utilization of Scientists and Engineers. Cambridge, Massachusetts: M.I.T. Press, 1971, 180.

233. Seaborg, Glenn T. and Daniel M. Wilkes. Education and the Atom. New York: McGraw-Hill, 1964, 150.

234. Skinner, B. F. The Technology of Teaching. New York: Appleton-Century-Crofts, 1968, 271.

235. Snow, Charles P. The Two Cultures and the Scientific Revolution. New York: Cambridge University Press, 1959, 107.

236. Steinhart, John S. and Stacie Cherniack. The Universities and Environmental Quality: Commitment to Problem Focused Education. A Report to the President's Environmental Quality Council. Washington, D. C.: Office of Science and Technology, 1969, 22.

237. Stratton, Julius A. Science and the Educated Man. Cambridge, Massachusetts: M.I.T. Press, 1966, 140.

238. Strickland, Stephen P., ed. Sponsored Research in American Universities and Colleges. Washington, D. C.: American Council on Education, 1968, 247.

239. Thompson, Walter P. Graduate Education in the Sciences in Canadian Universities. Toronto: University of Toronto Press, 1963, xii, 112.

240. U. S. Bureau of the Budget. The Administration of Government-Supported Research at Universities. Washington, D. C.: U. S. Government Printing Office, 1966, 141.

241. U. S. Congress. House. Committee on Education and Labor. To Improve Learning. A Report to the President and the Congress by the Commission on Instructional Technology, 91st Congress, 2nd Session, March, 1970. Washington, D.C.: U. S. Government Printing Office, 1970, 124.

242. U. S. Congress. House. Committee on Government Operations. Subcommittee on Research and Technical Programs. Conflicts between Federal Reseatch Programs and the Nation's Goals for Higher Education. Hearings before the Subcommittee to the 89th Congress, 1st Session, June 14, 15, and 17, 1965. Washington, D.C.: U.S. Government Printing Office, 1965, 202.

243. ________. Committee on Merchant Marine and Fisheries. Subcommittee on Oceanography. Sea Grant College Program. Hearings before the Subcommittee to the 90th Congress, 2nd Session, March 14, 1968. Washington, D.C.: U.S. Government Printing Office, 1968, 37.

244. ________. Committee on Science and Astronautics. The Management of Information and Knowledge. A Compilation of Papers Prepared for the Eleventh Meeting of the Panel on Science and Technology for the 91st Congress, 2nd Session, April 21, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 130.

245. ________. Committee on Science and Astronautics. The Management of Information and Knowledge. Proceedings of the Eleventh Meeting of the Panel on Science and Technology before the 91st Congress, 2nd Session, January 27-29, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 237.

246. ________. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Institutional Grants Bill. Hearings before the Subcommittee to the 91st Congress, 1st Session, February, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 351.

247. ________. Select Committee on Government Research. Study Number V: Federal Student Assistance in Higher Education. Hearings before the Committee to the 88th Congress, 2nd Session, 1964. Washington, D.C.: U.S. Government Printing Office, 1964, 100.

248. U.S. Congress. Senate. Committee on Aeronautical and Space Sciences. The Impact of the Space Age on Education in the United States, 1957-1969. A Selected, Annotated Bibliography Prepared for the Committee and presented to the 91st Congress, 1st Session, September, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 21.

249. U.S. Department of Labor. Bureau of Statistics. Federal Spending and Scientist and Engineer Employment. Washington, D.C.: U.S. Government Printing Office, 1970, 46.

250. U. S. Federal Council for Science and Technology. Interagency Committee on Oceanography. University Curricula in Oceanography: Academic Year 1965-1966. Washington, D.C.: U.S. Atomic Energy Commission, 1965, 116. (Interagency Committee on Oceanography, pamphlet No. 23)

251. U. S. Office of Science and Technology. Committee on Federal Laboratories. Catalog of Federal Laboratory-University Programs and Relationships. Report to the Federal Council for Science and Technology. Washington, D.C.: U.S. Government Printing Office, 1969, 76.

252. U. S. President's Science Advisory Committee. Education for the Age of Science. Washington, D.C.: U.S. Government Printing Office, 1959, 36.

253. ________. Meeting Manpower Needs in Science and Technology: Report Number One, Graduate Training in Engineering, Mathematics, and Physical Sciences. Washington, D.C.: U.S. Government Printing Office, 1962, 45.

254. ________. Scientific Progress, the Universities, and the Federal Government: A Statement. (The Seaborg Report). Washington, D.C.: U.S. Government Printing Office, 1960, 33.

255. University of Virginia. Center for the Study of Science, Technology, and Public Policy. Second Annual Report. Charlottesville: University of Virginia, 1970, 24.

256. Van Tassel, David D. and Michael G. Hall, eds. Science and Society in the United States. Homewood, Illinois: Dorsey Press, 1966, 360.

LEADING QUESTIONS

1. What are the distinctions usually drawn between scientific and technical education? Are these distinctions valid? Can or should scientific and technical education be kept separate?

2. What has been the history of government support for education in science and for technology? In the U.S.A.? In other countries? What seems to be the explanation of these patterns of support?

3. In what ways have science and technology contributed to the organization and methods of higher education? Can you cite specific examples of scientific instrumentation, information handling, teaching methods, and tests and measurements?

4. Why has scientific and technical education come to be described as "the knowledge business"? What is the explanation of the growing relationship between advanced scientific and technical education and economic growth?

5. What changes in fundamental education would be necessary to produce a "Third Culture" society? What would be necessary to achieve these changes?

6. What evidence, if any, indicates impending changes in science education in the United States? What appears to be the nature and direction of the trends? To what extent is specific governmental action involved?

7. It has often been claimed that the importance given to research on the campuses has led to the neglect of teaching by faculty members? Do you think it would be in the interests of the students if faculty research were relegated to a secondary position?

8. If you were compiling a list of science experts to be consulted in the course of an archaeological "dig" in a city occupied more than 5,000 years ago, what specific fields of scientific expertise would be included?

9. Does application of scientific methods to the arts and humanities destroy their special character and value? E.g., has textual criticism undermined the scriptural basis of religion?

10. How would you answer the question posed by Kenneth Boulding: "Dare we take the social sciences seriously?"

II

THE ORGANIZATION OF SCIENCE AND TECHNOLOGY

The five topics in this section examine the way in which the technoscientific enterprise of modern society is put together. But because the context within which this section is placed is one of public policy (rather than of industrial or economic development, for example), its emphasis is upon the machinery of government-science relationships. In other contexts, the relationship of science and technology to manufacturing, commerce, or agriculture might be given comparable emphasis. Organization of technoscientific enterprise is best described where it has been most deliberately and elaborately developed. And as the Topics are designed to assist understanding of the problems and processes involved in public policy for science and technology, and not to describe all possible government-science relationships, attention has been focused on five major but contrasting national systems--those of the United States, the Soviet Union, the United Kingdom, France, and Western Germany. Several other national technoscientific systems might have been added, but their study would have contributed relatively less toward the objectives sought in this section. The structure of international scientific cooperation is described, and it is in this global context that the future of public policy for science and technology will inevitably, in large measure, be placed. A special aspect of the international character of science and technology is the concluding topic in this section--Technoscience in the Developing Countries.

TOPIC 06 SCIENCE AND GOVERNMENT: THE UNITED STATES

Salient characteristics of the organization of science in the United States have been (1) autonomy, (2) diversified foci of decision on public policy for science and technology, and (3) growing interrelationships with government and industry.

Extensive governmental involvement and leadership in public policy for science and technology dates from World War II. Although there had been a continuing sponsorship of science by the federal government since the administrations of Washington and Jefferson, the Congress and the states remained largely apathetic. The scientific activities of government in the United States were directed primarily toward practical ends such as aids to navigation, the exploration of the west, and the setting of scientific and technical standards.

During the Civil War, however, the federal government assumed a more positive posture toward applied science. In 1862 the first Morrill Act set aside public lands for the support of higher education in agriculture and mechanic arts. And in 1863 the National Academy of Sciences was established as an advisory body to the government. By 1884 the growth of scientific agencies had reached a point where their relationships and organization became the object of study by a joint commission of the Congress.

World War I brought about increased governmental concern for science and led to the establishment of the National Research Council. In agriculture, conservation, public health, and technical standards, government was already engaged in scientific work. The new field of aeronautics had been entered. By 1916 the general structure of science that was to prevail until World War II was completed.

World War II and its aftermath led to a major expansion of government's role in science. Nuclear energy and exploration of outer space brought totally new functions to government. Establishment of the National Science Foundation and expansion of the research support activities of the National Institutes of Health, in addition to large expenditures for defense-related research and development, made the United States government the major national force in science and technology. An advisory apparatus in the executive branch was created (President's Science Advisory Committee and Federal Council on Science and Technology) and new committees for scientific policy were created in the Congress. The Department of Science idea, proposed as early as 1885, was again considered, but not adopted. As a technoscientific society took shape in America there was growing public concern with the interrelationships between government, industry, and the universities, particularly in the allocation of funds for research and development and in public policy toward technological innovation.

TOPIC 06 SCIENCE AND GOVERNMENT: THE UNITED STATES

Selected Basic Readings:

Daddario, Emilio Q. "Needs for a National Policy," Physics Today, XXII (October, 1969), 33-38.

Handler, Philip. "Toward a National Science Policy," AIBS Bulletin (BioScience), XX (September 1, 1970), 971-977.

Perl, Martin L. "The Scientific Advisory System: Some Observations," Science, CLXXIII (September 24, 1971), 1211-1215.

Roback, Herbert. "Congress and the Science Budget," Science, CLX (May 31, 1968), 964-971.

Sapolsky, Harvey M. "Science Policy in American State Government," Minerva, IX (July, 1971), 322-348.

Supplementary and Substitute Readings:

Chapman, Richard L. "Congress and Science Policy: The Organizational Dilemma," Bulletin of the Atomic Scientists, XXV (March, 1969), 4-7, 28.

Dupree, A. Hunter. "Central Scientific Organization in the United States Government," Minerva, I (Summer, 1963), 453-469.

Hornig, Donald F. "U.S. Science Policy: Its Health and Future Direction," Science, CLXIII (February 7, 1969), 523-528.

Nature. "Does the U.S. Have a Science Policy?" Nature, CCXVII (January 20, 1968), 225-231.

Reagan, Michael D. "Congress Meets Science: The Appropriations Process," Science, CLXIV (May 23, 1969), 926-931.

TOPICAL OUTLINE | REFERENCE KEY

TOPICAL OUTLINE	REFERENCE KEY
I. Science and Public Affairs in the 18th Century	153, 184, 193, 209, 210, 238, 251, 299
A. Science in the colonies and confederation	
1. Influence of European science	
2. American Philosophical Society, 1743 (Franklin and Rittenhouse)	
3. American Academy of Arts and Sciences, 1780	
B. Science under the federal constitution	
1. Federalist concepts of government encouragement for science and technology	
2. Jeffersonian animadversions and practical compromises	
II. Science and Government in the 19th Century	184, 192, 193, 196, 197, 218, 238, 244, 253, 271, 299
A. Exploration and mapping of the continent	
1. U.S. Military Academy and Corps of Engineers, 1802	
2. The Lewis and Clark Expedition, 1804-1806	
3. The Coast Survey, 1807	
4. Department of the Interior, 1849	
5. The Geological Survey, 1879	130, 215, 252
B. Scientific institutions	
1. The Smithsonian Institution, 1846	
2. The American Association for the Advancement of Science, 1848	10, 11, 12
3. The National Academy of Sciences, 1863	145, 151
4. Agriculture and Mechanic Arts	20
a. Morrill Act of 1862--land grant colleges	
b. Hatch Act of 1887--agricultural experiment stations	
c. Cabinet status for agriculture, 1889	

5. The growth of the universities--higher education and scientific research
6. The Allison Commission and a proposed Department of Science, 1884-1886

III. Science and Government in World Wars I and II	184, 185, 193, 197, 200, 203, 238, 244, 249, 250, 314
A. New directions in government science in the pre-war period	196
1. National Bureau of Standards, 1901	23, 128, 189, 252
2. Pure Food and Drug Act, 19[illegible]	
3. Public Health Service, 1912	
4. National Advisory Committee for Aeronautics, 1915	
B. Science and technology in World War I	197
1. Naval Consulting Board, 1915	
2. The National Research Council, 1918	168, 169
C. Science and the Great Depression	197
1. Hoover Committee on Recent Social Trends, 1929 (cf. <u>Report of the Committee</u>, 1932)	
2. National Institutes of Health, 1930	143, 148, 158, 171
3. Science Advisory Board, 1933	
4. National Resources Committee (cf. <u>Research--A National Resource</u>, 1937)	
D. Science and technology in World War II and post-war period	38, 51, 92, 115, 185, 190, 212
1. Office of Scientific Research and Development	
2. Office of Naval Research	31, 122
3. The Manhattan Project	100
4. The Bush (<u>Science, the Endless Frontier</u>, 1945) and Steelman (<u>Science and Public Policy</u>, 1947) reports	186, 268

5. The Atomic Energy Commission, 1947	54, 80, 112, 116, 208, 211
6. The National Science Foundation, 1950	2, ~~15~~, 35, 81, 89, 252
7. Science and the Cold War--loyalty and security	61, 201, 207
a. The atomic scientists	264
b. The Oppenheimer case	270
IV. Contemporary Functions of Government in Relation to Science and Technology	83, 84, 87, 113, 123, 124, 125, 126, 129, 146, 149, 153, 160, 176, 182, 183, 191, 222, 229, 235, 247, 252, 261, 281, 312
A. Scientific and technological activities inside government	50, 305
1. Measurement and standards	23, 195, 303
2. Civil engineering	155
3. Military technology	31, 92, 122, 208
4. Agriculture	67, 97, 252
5. Natural resources management	57, 79, 257, 266
6. Health and safety	7, 8, 13, 86, 93, 102, 301
7. Atomic energy	33, ~~54~~, 63, 112, 259, 274, 277
8. Outer space exploration	36, 44, ~~96~~, 109, ~~141~~, 147, 204, 256, 300, 310
9. Environmental surveillance	19, 30, 57, 79, 175, 257, 283, 317
10. Marine and atmospheric sciences	4, 40, 107, 245, 267, 278, 280, 284, [illegible], 288, 304, 306, 307, 311

4. Federal research laboratories — 60, 71, 104, 106, 305

B. Formulation of policies affecting science and technology generally — 110, 182, 191, 229, 265, 274, 293, 309, 315

1. In connection with federal scientific and technical programs, e.g., via contract with DOD, NASA, AEC — 36, 58, 77, 91, 96, 127, 141, 142, 208, 226, 277, 304

2. Through the science advisory structure, e.g., Office of Science and Technology, Federal Council for Science and Technology, President's Science Advisory Committee, National Aeronautics and Space Council, Council on Environmental Quality, National Academy of Sciences, National Academy of Engineering, Smithsonian Institution — 1, 3, 16, 22, 28, 37, 48, 64, 73, 82, 121, 124, 134, 151, 152, 164, 285, 286, 290, 308, 309, 312

3. Through the administration of research grants, fellowships, and other assistance to scientific research and education, e.g., through the U.S. Public Health Service and National Institutes of Health, U.S. Office of Education, National Science Foundation — 2, 35, 42, 46, 59, 90, 99, 118, 119, 137, 156, 163, 167, 170, 174, 177, 217, 222, 224, 288, 289

4. Through cooperation with international efforts in science and technology — 56, 255, 281, 282

C. Review and assessment of the status and direction of public policy and administration affecting science and technology — 17, 34, 47, 45, 64, 66, 74, 88, 157, 166, 179, 182, 229, 276, 299, 313

1. The Congress of the United States, e.g., House of Representatives: Committee on Science and Astronautics; Committee on Agriculture; Committee on Armed Services; Committee on Interstate and Foreign Commerce; Senate: Committee on Aeronautical and Space Sciences; Committee on Agriculture and Forestry; Committee on Appropriations; Committee on Armed Services; Committee on Commerce; and Library of Congress, Science and Technology Division — 5, 26, 29, 43, 52, 79, 85, 94, 132, 135, 165, 180, 181, 221, 291, 293, 295, 297, 298, 299, 302

2. Executive Committees or Commissions, e.g., Steelman and Bush reports, Environmental Pollution Panel of the President's Science Advisory Committee, National Council on Marine Resources and Engineering Development — 124, 267, 285, 309, 312

3. Analysis and criticism of United States science policy structure (see also Topic 11) — 1, 27, 45, 66, 101, 120, 160, 178

   a. Centralization of Federal science responsibilities — 292

      1. The Department of Science idea, 1884-1971 — 39, 49, 76, 103, 136, 138, 182

      2. Proposal for National Institutes of Research and Advanced Studies — 294

   b. Over-emphasis on mission oriented technological programs, e.g. Apollo, SST, Atomic Energy, etc. — 36, 54, 58, 77, 111, 116, 221

c. Support of basic research by the DOD--the Mansfield proposal — 24, 99, 111, 142

d. Intermittent nature of funding for science programs — 17, 21, 25, 98, 133, 144, 159, 172, 178

e. Insufficient attention to social and behavioral science--proposal for a National Social Science Foundation — 117, 180

V. Science and the States — 139, 140, 219, 227

A. Role of State governments in the promotion of science and technology in the 19th century and up to World War II. Involvement proportionately greater than it is today, and as extensive as that of the federal government at the time. Initiation of programs in
1. Agricultural experimentation
2. Geological mapping
3. Higher education
4. Public health

B. Decrease in relative support by State governments for technoscientific research & development after World War II due to vastly larger federal outlays (contribution of state agencies to total national R & D is about 0.5 percent, compared to about 66 percent for federal agencies).
State supported R & D heavily concentrated in:
1. Health care (more than 40 percent of total states R & D). — 254
2. Natural resources (25 percent)
3. Highways (15 percent)

C. Lack of support by states of basic research at colleges and universities (except for agricultural research), due to
1. General lack of interest among State governments in science per se or in academic research; teaching function of the university emphasized.

2. State priority assigned to projects which show tangible results in a comparatively short time.
3. Results of successful research financed by one state will be quickly available to other who did not pay for it.

D. Recent Federal support of state technoscientific activities; some examples: 49, 223, 254
1. State Technical Services (STS) Program, 1965-1969 62, 150
2. Intergovernmental Cooperation Act of 1968
3. Maritime states helped by the Sea Grant College Act of 1966
4. The Anadromous Fish Concentration Act of the 89th Congress
5. National Science Foundation Grant to Council of State Governments 69

E. Institutional Structure for technoscientific advice to State governments 55, 97, 187, 232
1. Functions
   a. Acceleration of economic development
   b. Anticipation and solution of social problems
   c. Examination of natural resource and environmental problems
   d. Injecting benefits of science and technology into State government planning and management
   e. Setting of goals and appraising of progress in areas requiring the use of science and technology
2. Type of structure 199
   a. Science Advisor to the Governor
   b. Science Advisory Council
   c. State Science Foundations 236
   d. Academies of Science
   e. Combinations of some of the above
3. State technoscientific development programs, e.g., 154, 198, 205, 220, 228, 230, 231, 233, 237, 246, 254, 272, 275
   a. Information technology

b. Environmental research — 68, 95, 266
c. Systems analysis
d. Natural areas for research
e. State museums
f. Cooperative programs between several states — 214, 234, 248

4. Ineffectiveness of most state science policy structures due to
   a. Absence of clear indication of correlation between investment in technoscience and economic gain
   b. Lack of recognition of role of science advisers in the formulation of public policy
   c. Impermanence of advisers, who seldom survive a change in administration
   d. Lack of effective institutionalization of science policy in the regular structure of the legislative and executive branches

BIBLIOGRAPHY

General References: Articles

1. Abelson, Philip H. "The President's Science Advisers," Minerva, III (Winter, 1965), 149-158.

2. Allison, David. "The National Science Foundation," International Science and Technology, Number 52 (April, 1966), 76-86.

3. ________. "The Science Brain Trust," International Science and Technology, Number 37 (January, 1965), 61-68.

4. Anastasion, Steven N. "Oceanography and Government," in Ocean Sciences, ed. by Edward J. Long. Annapolis, Maryland: U.S. Naval Institute, 1964, 185-[illegible].

5. Anderson, Clinton P. "Scientific Advice for Congress," Science, CXLIV (April 3, 1964), 29-32.

6. Anderson, Clinton P. and James T. Ramey. "Congress and Research: Experience in Atomic Research and Development," Annals of the American Academy of Political and Social Science, CCCXXVII (January, 1960), 85-94.

7. Bazell, Robert J. "Food and Drug Administration: Is Protecting Lives the Priority?" Science, CLXXII (April 2, 1971), 41-43.

8. Bernhard, Robert. "Cyclamate - Contradictions and Loose Ends," Scientific Research, IV (November 24, 1969), 18-21.

9. Bertin, L. "Science Policy in Canada," Technology Review, LXXIII (February, 1971), 35; 37-39.

10. Boffey, Philip M. "AAAS (I): Facing the Questions of What It Should Be and Do," Science, CLXXII (April 30, 1971), 453-458.

11. ________. "AAAS (II): What It Is and What It Tries to Do," Science, CLXXII (May 7, 1971), 542-547.

12. ________. "AAAS (III): Is Order-of-Magnitude Expansion a Reasonable Goal?" Science, CLXXII (May 14, 1971), 656-658.

13. Boffey, Philip M. "Nader's Raiders on the FDA: Science and Scientist Misused," Science, CLXVIII (April 17, 1970), 349-352.

14. ________. "NSF Budget: House Group Reacts to Data on Plight of Science," Science, CLXVIII (April 3, 1970), 95-97.

15. ________. "NSF: McElroy Seeks to Impart Political Headway to Agency," Science, CLXVI (October 24, 1969), 481-485.

16. ________. "Science Policy: An Insider's View of LBJ, DuBridge, and the Budget," Science, CLXXI (March, 1971), 874-876.

17. ________. "Technology and World Trade: Is There Cause for Alarm?" Science, CLXXII (April 2, 1971), 37-41.

18. Boffey, Philip M., Luther J. Carter, and Andrew Hamilton. "Nixon Budget: Science Funding Remains Tight," Science, CLXVII (February 6, 1970), 845-848.

19. Bowers, Raymond, Paul Hohenberg, Gene Likens, Walter Lynn, Dorothy Nelkin, and Mark Nelkin. "A Program to Coordinate Environmental Research," American Scientist, LIX (March-April, 1971), 183-187.

20. Bradford, Richard. "The Sciences, Pure and Applied, in the First Century of the Land Grant Institutions," Science Education, XLVI (April, 1962), 240-247.

21. Brode, W. R. "The Handwriting on the Wall," American Scientist, LVI (Summer, 1968), 119A-120A; 122A-123A.

22. Brown, H. "Some Thoughts on the National Academy of Sciences and the Role of Nongovernmental Institutions," Congressional Record, CXVII (May 20, 1971), E4751-E4755.

23. Bulletin of the Atomic Scientists. "Functions and Operations of the Bureau of Standards," Bulletin of the Atomic Scientists, IX (December, 1953), 376-377. A summary of the Kelly Report. See also Science, CXIX (February 12, 1954), 195-200, and Nature, CCIV (December 12, 1964), 1039-1040.

24. ________. "Mission Agency Support of Basic Research," Bulletin of the Atomic Scientists, XXVI (September, 1970), 35-37.

25. Bylinsky, G. "U.S. Science Enters a Not-So-Golden Era," Fortune, LXXVIII (November, 1968), 144-147; 197; 199-200; 202; 205-206.

26. Califano, J. A., Jr. "The Separate but Unequal Branch--Congress Has Been Bypassed in Analysis Technology," Congressional Record, CXVII (July 14, 1971), S10915-S10917.

27. Calkins, Robert D. "The National University," Science, CLII (May 13, 1966), 884-889.

28. Carey, William D. "Budgeting for Science: Presidential Responsibility," Annals of the American Academy of Political and Social Science, CCCXXVII (January, 1960), 76-84.

29. Carpenter, Richard A. "Science, Policy, and Congress," Midwest Research Institute Quarterly. (Winter, 1968-1969), 4-7; 20-21.

30. Carter, Luther J. "Environment Quality: Nixon's New Council Raises Doubts," Science, CLXV (July 4, 1969), 44-46.

31. ________. "Office of Naval Research: 20 Years Bring Changes," Science, CLXIII (July 22, 1966), 397-400.

32. ________. "Project Bomex: Biggest Weather Study Yet," Science, CLXIII (March 28, 1969), 1435-1436.

33. Cavers, David F. "The Atomic Energy Action of 1954," Scientific American, CXCI (November, 1954), 31-35.

34. Chapman, Richard L. "Congress and Science Policy: The Organizational Dilemma," Bulletin of the Atomic Scientists, XXV (March, 1969), 4-7; 28.

35. Chemical and Engineering News. "Developing a National Science Foundation," Chemical and Engineering News, XXXI (January 19, 1953), 228-233.

36. ________. "United States in Space," Chemical and Engineering News, XLI (September 23, 1963), 98-128. (Part I)

37. ________. "White House Superstructure for Science," Chemical and Engineering News, XLII (October 19, 1964), 78-92.

38. Compton, Karl T. "Science and National Policy," Scientific Monthly, LXIII (August, 1946), 125-128.

39. Congressional Record. "Establishment of a Department of Science and Technology in the Executive Branch," Congressional Record, CXVI (December 19, 1970), 20788-20789.

40. ________. "National Oceanic Act of 1971," Congressional Record, CXVII (June 3, 1971), S8086-S8089.

41. ________. "The Technology Assessment Act of 1970," Congressional Record, CXVI (April 16, 1970), H3225-H3226.

42. Cooper, Joseph D. "Onward the Management of Science: The Wooldridge Report," Science, CXLVIII (June 11, 1965), 1433-1439.

43. Cote, Alfred J., Jr. "Who Tells Congress about Technology?" Industrial Research, IX (September, 1967), 78-82.

44. Daddario, Emilio Q. "Congress Faces Space Policies," Bulletin of the Atomic Scientists, XXIII (May, 1967), 11-16.

45. ________. "Needs for a National Policy," Physics Today, XXII (October, 1969), 33-39.

46. ________. "A Revised Charter for the Science Foundation," Science, CLII (April 1, 1966), 42-45.

47. ________. "Science...and Public Policy," Physics Today, XVIII (January, 1965), 23-26.

48. David, Edward E., Jr. "Toward New Initiatives," Technology Review, LXXIII (February, 1971), 25-27.

49. DuBridge, Lee A. "Federal-State Collaboration in Science and Technology," Address at the National Governor's Conference, Colorado Springs, Colorado, September 3, 1969, 12.

50. Dupree, A. Hunter. "Central Scientific Organization in the United States Government," Minerva, I (Summer, 1963), 453-469.

51. Dupree, A. Hunter. "A New Rationale for Science," Saturday Review, LIII (February 7, 1970), 55-57.

52. Etzioni, Amitai. "How May Congress Learn?" Science, CLIX (January 12, 1968), 170-172.

53. Fitzpatrick, J. "A Crisis Facing American Science," Technology Review, LXXI (March, 1969), 8-11.

54. Fozzy, Paula. "Two Views of Nuclear Power: AEC, Industry," Bulletin of the Atomic Scientists, XIX (June, 1963), 37-38.

55. Fritschler, A. L. and J. E. Underwood. "Science-Technology Advice in Local Governments," Urban Data Service, II (November, 1970), 48.

56. Frutkin, Arnold W. "Joint Enterprises Are Now a Going Concern in the Exciting Field of Space Research," UNESCO Courier, XIX (May, 1966), 13-16.

57. Gillette, R. "Environmental Protection Agency: Chaos or 'Creative Tension'?" Science, CLXXIII (August 20, 1971), 703-707.

58. Greenberg, Daniel S. "Civilian Technology: NASA Study Finds Little 'Spin Off'," Science, CLVII (September 1, 1967), 1016-1018.

59. ________. "Daddario Study Says NSF Should Be Forefront of Policy-Making," Science, CLI (January 14, 1966), 177-179.

60. ________. "Federal Labs: Daddario Committee Holds Probe on Their Utilization," Science, CLX (April 19, 1968), 288-290.

61. Haberer, Joseph. "Politics and the Community of Science," American Behavioral Scientist, X (May, 1967), 10-12, 21-23.

62. Hamilton, Andrew. "State Technical Services: Congress Swings the Axe," Science, CLXVI (December 26, 1969), 1606-1608.

63. Hamilton, Walter A. "McKinney Review of U.S. Atomic Policies," Bulletin of the Atomic Scientists, XVII (January, 1961), 25-29, 40.

64. Handler, Philip. "Federal Science Policy," Science, CLV (March 3, 1967), 1063-1066.

65. Handler, Philip. "National Planning for Medical Research," Science, CXLVIII (June 25, 1965), 1688-1692.

66. ________. "Toward a National Science Policy," AIBS Bulletin (BioScience), XX (September 1, 1970), 971-977.

67. Hardin, Charles M. "Reflections on Agricultural Policy Formation in the United States," American Political Science Review, XLII (October, 1948), 881-905.

68. Haskell, Elizabeth H. "State Governments Tackle Pollution," Environmental Science and Technology, V (November, 1971), 1092-1097.

69. Hersman, M. F. "Intergovernmental Science Programs: Federal Initiatives," Science and Public Policy Studies Group Newsletter, II (May, 1971), 3-5.

70. Hookway, H. T. "The Office for Scientific and Technical Information," Nature, CCVII (July 17, 1965), 234-236. (British experience)

71. Hornig, Donald F. "Federal Research Laboratories," Science, CLX (May 10, 1968), 627-628.

72. ________. "National Science Foundation," Chemical and Engineering News, XLIII (July 5, 1965), 62-65.

73. ________. "The President's Special Assistant for Science and Technology Addresses the American Physical Society," Physics Today, XVII (July, 1964), 34-38.

74. ________. "U.S. Science Policy: Its Health and Future Direction," Science, CLXIII (February 7, 1969), 523-528.

75. Hull, E. W. Seabrook. "The Political Action," International Science and Technology, LXIV (April, 1967), 48-50.

76. Humphrey, Hubert H. "The Need for a Department of Science," Annals of the American Academy of Political and Social Science, CCCXXVII (January, 1960), 27-35.

77. Hyatt, Abraham. "Beyond Apollo," International Science and Technology, Number 63 (March, 1967), 30-39.

78. Industrial Research. "DuBridge: No Department of Science," Industrial Research, XI (October, 1969), 37-38.

79. Jackson, Henry M. "Environmental Policy and the Congress," Public Administration Review, XXVIII (July-August, 1968), 303-305.

80. Johnson, T. H. "AEC--Research Program and Policy," Physics Today, VII (August, 1954), 14-17.

81. Jones, Alfred W. "The National Science Foundation," Scientific American, CLXXVIII (June, 1948), 7-10.

82. Kantrowitz, Arthur. "Proposal for an Institution for Scientific Judgment," Science, CLVI (May 12, 1967), 763-764.

83. Kennedy, John F. "Research, Technology, and Public Policy," Physics Today, XVI (December, 1963), 23-26.

84. Kistiakowsky, George B. "National Policy for Science," Chemical and Engineering News, XL (January 22, 1962), 120-124.

85. Kofmehl, Kenneth. "COSPUP, Congress, and Scientific Advice," Journal of Politics, XXVIII (February, 1966), 100-120.

86. Lee, Philip R. "Role of the Federal Government in Health and Medical Affairs," New England Journal of Medicine, CCLXXIX (November 21, 1968), 1139-1147.

87. Leiserson, A. "Science and Government," in American Politics and Government: Essays in Essentials, ed. by S. K. Bailey. New York: Basic Books, 1965, 251-262.

88. Lepkowski, W. "Federal Technology Policy Begins to Take Shape," Product Engineering (Februay 16, 1970), 24-26.

89. Lessing, Lawrence P. "The National Science Foundation," Scientific American, CXC (March, 1954), 29-33.

90. Levin, Louis. "The Role of the National Science Foundation in Biological Science," AIBS Bulletin (BioScience), IV (October, 1954), 19-21,

91. Lewis, Richard S. "The End of Apollo," Bulletin of the Atomic Scientists, XXIV (September, 1968), 2-6.

92. Likely, Wadworth. "Science and Mobilization," Science, CXII (September 29, 1950), 349-352.

93. Lindsay, Dale R. and Ernest M. Allen. "Medical Research: Past Support, Future Directions," Science, CXXXIV (December 22, 1961), 2017-2024.

94. Lowe, George E. "Congress and Scientific Advice," Bulletin of the Atomic Scientists, XXI (December, 1965), [illegible]-42.

95. McClellan, J. L. "Environmental Matters on the State Level," Congressional Record, CXVII (June 21, 1971), S9555-S9557.

96. MacDonald, Gordon J. F. "Science and Space Policy: How Does It Get Planned?" Bulletin of the Atomic Scientists, XXIII (May, 1967), 2-9.

97. Maher, T. J. "Public Technology for State Government," State Government, XLIV (Summer, 1971), 142-148.

98. Mainzer, Lewis C. "Science Democratized: Advisory Committees on Research," Public Administration Review, XVIII (Autumn, 1958), 314-323.

99. Mansfield, Michael. "Rechanneling the Public Resources for Basic Science through the Civilian Agencies: A New Goal for National Science Policy," Congressional Record, CXVI (August 21, 1970), S13932-S13934.

100. Marks, Herbert S. "Congress and the Atom," Bulletin of the Atomic Scientists, V (February, 1949), 44-47.

101. Michaelis, Michael. "Can We Build the World We Want?" Bulletin of the Atomic Scientists, XXIV (January, 1968), 43-49.

102. Mintz, Morton. "FDA and Panalba: A Conflict of Commerical, Therapeutic Goals?" Science, CLXV (August 29, 1969), 875-881.

103. Montoya, Joseph M. "The Department of Science and Technology Act of 1971," Congressional Record, CXVII (March 10, 1971), S2800-S2812.

104. Moravcsik, Michael J. "Reflections on National Laboratories," Bulletin of the Atomic Scientists, XXVI (February, 1970), 11-15.

105. Moulton, F. R. "The American Association for the Advancement of Science: A Brief Historical Sketch," Science, CVIII (September 3, 1948), 217-218; "The AAAS and Organized American Science," Ibid. (November 26, 1948), 573-577.

106. Mozley, Ann. "Change in Argonne National Laboratory: A Case Study," Science, CLXXIII (October 1, 1971), 30-38.

107. Murphy, Thomas P. "Mobilization for the National Program in Marine Sciences," Public Administration Review, XXIX (May-June, 1969), 263-275.

108. Nature. "Does the U.S. Have a Science Policy?" Nature, CCXVII (January 20, 1968), 225-231.

109. Newell, Homer E. "NASA and Space," Bulletin of the Atomic Scientists, XVII (May-June, 1961), 222-229. (Note other articles on NASA in this issue.)

110. New Scientist. "Scientific Advice for American Government," New Scientist, XXII (June 25, 1964), 800-803.

111. Nichols, Rodney W. "Mission-Oriented R & D," Science, CLXXII (April 2, 1971), 29-37.

112. Niehoff, Richard O. "Organization and Administration of the United States Atomic Energy Commission," Public Administration Review, VIII (Spring, 1948), 91-102.

113. Nixon, Richard M. "The Scientific Revolution," Bulletin of the Atomic Scientists, XVI (November, 1960), 348-351.

114. OECD Observer. "Science Policy in the United States," OECD Observer, Number 32 (February, 1968), 29-32.

115. Office of Defense Mobilization. Science Advisory Committee. "Science and Mobilization," Physics Today, IV (November, 1951), 4-5.

116. Orford, Roy C. "The America Long-Term View of Nuclear Power," New Scientist, XVI (December 13, 1962), 632-634.

117. Orlans, Harold. "Social Science Research Policies in the United States," Minerva, IX (January, 1971), 7-31.

118. Overman, John R. "Collaborative Research: Partnership for Progress," Lex et Scientia, III (April-June, 1966), 74-80.

119. Page, H. E. "Lessons of the NSF Science Development Program," Educational Record, XLVII (Winter, 1966), 50-56.

120. Perl, Martin L. "The 'New Critics' in American Science," New Scientist, XLVI (April 9, 1970), 63-65.

121. ________. "The Scientific Advisory System: Some Observations," Science, CLXXIII (September 24, 1971), 1211-1215.

122. Pfeiffer, John E. "The Office of Naval Research," Scientific American, CLXXX (February, 1949), 11-15.

123. Piore, Emmanuel R. and R. N. Kreidler. "Recent Developments in the Relationship of Government to Science," Annals of the American Academy of Political and Social Science, CCCXXVII (January, 1960), 10-18.

124. Price, Don K. "Federal Money and University Research," Science, CLI (January 21, 1966), 285-290.

125. ________. "The Organization of Science Here and Abroad," Science, CXXIX (March 20, 1959), 759-765.

126. Price, Don K., J. Stefan Dupre, and W. Eric Gustafson. "Current Trends in Science Policy in the United States," Impact of Science on Society, X (Number 3, 1960), 187-211.

127. Price, W. J. "The Case for Agency Research," Bulletin of the Atomic Scientists, XXV (April, 1969), 34-36.

128. Pursell, Carroll W., Jr. "A Preface to Government Support of Research and Development: Research Legislation and the National Bureau of Standards, 1935-1941," Technology and Culture, IX (April, 1968), 145-164.

129. ________. "Some Recent Government Publications Concerning Technology," Technology and Culture, IX (January, 1968), 90-93.

130. Rabbitt, John C. and Mary C. Rabbitt. "The U.S. Geological Survey, 75 Years of Service to the Nation, 1879-1954," Science, CXIX (May 28, 1954), 741-758.

131. Randers, Gunnar. "Atomic Energy and Private Enterprise: Joint Committee Hearings," Bulletin of the Atomic Scientists, IX (October, 1953), 309-314.

132. Reagan, Michael D. "Congress Meets Science: The Appropriations Process," Science, CLXIV (May 23, 1969), 926-931.

133. Reinhold, R. "A Depression for Science?" Bulletin of the Atomic Scientists, XXIV (October, 1968), 4-8.

134. Rischer, C. W. "Scientists and Statesmen: A Profile of the President's Science Advisory Committee," in Knowledge and Power: Essays on Science and Government, ed. by Sanford A. Lakoff. New York: Free Press, 1966, 315-358.

135. Roback, Herbert. "Congress and the Science Budget," Science, CLX (May 31, 1968), 964-971.

136. ________. "Do We Need a Department of Science and Technology?" Science, CLXV (July 4, 1969), 36-43.

137. Rosenberg, Herbert H. "Research Planning and Program Development in the National Institutes of Health: The Experience of a Relatively New and Growing Agency," Annals of the American Academy of Political and Social Science, CCCXXVII (January, 1960), 103-113.

138. Runnels, H. "Introduction of the Science and Technology Act of 1971," Congressional Record, CXVII (March 10, 1971), E1759-E1760.

139. Sapolsky, Harvey H. "Science Advice for State and Local Government," Science, CLX (April 19, 1968), 280-284.

140. ________. "Science Policy in American State Government," Minerva, IX (July, 1971), 322-348.

141. Schoettle, E. C. "The Establishment of NASA," in Knowledge and Power: Essays on Science and Government, ed. by Sanford A. Lakoff. New York: Free Press, 1966, 162-270.

142. Science. "Pentagon Promises to Observe Congressional Curbs on Research," Science, CLXVI (December 12, 1969), 1386-1387.

143. Sebrell, W. H., Jr. and C. V. Kidd. "Administration of Research in the National Institutes of Health," Scientific Monthly, LXXIV (March, 1952), 152-161.

144. Seitz, Frederick. "After Vietnam--Will Science Regain Support?" Scientific Research, III (June 10, 1968), 28-29.

145. ________. "The National Academy of Science of the United States of America," Impact of Science on Society, XIV (Number 2, 1964), 74-82.

146. ________. "Science and the Government," Physics Today, XVI (December, 1963), 28-32.

147. ________. "Science and the Space Program," Science, CLII (June 24, 1966), 1719-1721.

148. Shannon, James A. "The Place of the National Institutes of Health in American Medicine," New England Journal of Medicine, CCLXIX (December 19, 1963), 1352-1357.

149. ________. "Science and Federal Programs: The Continuing Dialogue," Science, CXLIV (May 22, 1964), 976-978.

150. Silva, D. H. "State Technical Service--An Emerging Social System," American Journal of Economics and Sociology, XXVIII (October, 1969), 399-404.

151. Simons, Howard. "The Academicians of Washington," New Scientist, XX (October 17, 1963), 136-139.

152. Small, William E. "Hornig and the OST: The First 1,162 Days," Scientific Research, II (April, 1967), 63-67.

153. Smyth, Henry D. "Science and the Federal Government," Physics Today, XI (June, 1958), 10-14.

154. Stevens, C. H. "A State That Listens to Citizens and Science," New Scientist and Science Journal, XLIX (February 11, 1971), 298-300.

155. Stratton, Julius A. "Advice to a New Academy--The Engineering Academy, Founded on the Same Principles as the NAS, Faces Different, Important Tasks," Science, CXLIX (September 10, 1965), 1206-1208. See also Science, CXLVI (December 25, 1964), 1661-1662.

156. Strickland, Stephen P. "Integration of Medical Research and Health Policies," Science, CLXXIII (September 17, 1971), 1093-1103.

157. Sutherland, Gordon. "Some Aspects of the U.S.A. Today: Science," American Scientist, LV (September, 1967), 296-310.

158. Swain, Donald C. "The Rise of a Research Empire: NIH, 1930-1950," Science, CXXXVIII (December 14, 1962), 1233-1237.

159. Szent-Gyorgi, A. "Science and Budget-Cutting," Bulletin of the Atomic Scientists, XXV (December, 1969), 16-17.

160. Teller, Edward. "The Era of Big Science," Bulletin of the Atomic Scientists, XXVII (April, 1971), 34-36.

161. Todd, W. Murray. "Science in the State Department," Bulletin of the Atomic Scientists, XX (December, 1964), 27-29.

162. Turrer, Joseph. "First Scientific Bureau," Science, CXXV (February 8, 1957), 217.

163. U.S. Congress. "Leadership in Science Policy," in The National Science Foundation--Its Present and Future. Report of the House Committee on Science and Astronautics, 89th Congress, 2nd Session, February 1, 1966, 42-47.

164. Vohra, Hans R. "Ministry of Science--U.S. Style," Bulletin of the Atomic Scientists, XXVII (January, 1971), 29-32.

165. ________. "Science in Congress," Bulletin of the Atomic Scientists, XXVII (February, 1971), 44-46.

166. Waddington, Conrad H. "A British Perspective on American Science Policy," Science, CLX (April 5, 1968), 46-48.

167. Walker, Eric A. "National Science Board: Its Place in National Policy," Science, CLVI (April 28, 1967), 474-477.

168. Walsh, John. "National Research Council: And How It Got That Way," Science, CLXXII (April 16, 1971), 242-246.

169. ________. "National Research Council (II): Answering the Right Questions?" Science, CLXXII (April 23, 1971), 353-357.

170. ________. "NIH: Another Tight Budget, Fewer Friends in High Places," Science, CLXIV (April 11, 1969), 165-167.

171. ________. "NIH: Demand Increases for Applications of Research," Science, CLIII (July 8, 1966), 149-152.

172. ________. "Science Policy: Budget Cuts Prompt Closer Look at the System," Science, CLXVIII (May 15, 1970), 802-805.

173. ________. "Science Policy: When Congress Looks for a Leader NSF Is Usually Nominated," Science, CLII (April 8, 1966), 184-185.

174. Waterman, Alan T. "The Role of the National Science Foundation," Annals of the American Academy of Political and Social Science, CCCXXVII (January, 1960), 128-131.

175. Wenk, Edward, Jr. "Federal Policy Planning for the Marine Environment," Public Administration Review, XXVIII (July-August, 1968), 312-320.

176. Whitney, Vincent H. "Science, Government, and Society," Annals of the American Academy of Political and Social Science, CCCXXVII (January, 1960), 50-58.

177. Wilson, John T. "Support of Research by NSF," AIBS Bulletin (BioScience), XI (December, 1961), 21-24; 31.

178. Wolfle, Dael. "Science and Engineering Policies in Transition," Science, CLXIII (January 17, 1969), 306; 308; 310.

179. Wormuth, Francis O. "Government and Science," Center Magazine, III (March-April, 1970), 41-46.

General References: Books

180. Brezina, D. W. The Congressional Debate on the Social Sciences in 1968. Washington, D.C.: George Washington University, 1968, 21.

181. Brezina, D. W. The Rise and Demise of the Senate Subcommittee on Government Research. Washington, D.C.: Progam of Policy Studies in Science and Technology, George Washington University, 1969, 31.

182. Brooks, Harvey. The Government of Science. Cambridge, Massachusetts: M.I.T. Press, 1968, 343.

183. Brown, F. R. and S. W. Chitwood. Highlights from the Literature on Organization for Federal Programs in Science and Technology. Commission on Marine Science, Engineering, and Resources. Washington, D.C.: George Washington University, 1968, 138.

184. Burnham, John C. Science in America: Historical Selections. New York: Holt, Rinehart, and Winston, 1971, 496.

185. Bush, Vannevar. Pieces of the Action. New York: Morrow, 1970, 366.

186. ________. Science, The Endless Frontier: A Report to the President on a Program for Postwar Scientific Research. U.S. Office of Scientific Research and Development. Report of the Director, July, 1945. Washington, D.C.: National Science Foundation, 1960, 220.

187. California Legislature. Assembly General Research Committee. 1970 Annual Report, Assembly Science and Technology Advisory Council. Sacramento, California: California State Legislature, 1971, 15.

188. Cleaveland, Frederic N. Science and State Government: A Study of State Government Activities in Six States. Chapel Hill: University of North Carolina Press, 1959, 161.

189. Cochrane, Reymond C. Measures for Progress: A History of the National Bureau of Standards. Washington, D.C.: National Bureau of Standards, U.S. Department of Commerce, 1966, 703.

190. Conant, James B. My Several Lives: Memoirs of a Social Inventor. New York: Harper and Row, 1970, 701.

191. Danhof, D. H. Interdependence between Public and Private Interests in the Advancement of New Technologies. Washington, D.C.: George Washington University, 1968, 67.

192. Daniels, George H. American Science in the Age of Jackson. New York: Columbia University Press, 1968, 282.

193. ________. Science in American Society: A Social History. New York: Knopf, 1971, 390.

194. De Grazia, Alfred. The Velikovsky Affair: The Warfare of Science and Scientism. New Hyde Park, New York: University Books, 1966, 260.

195. De Simone, D. V. A Metric America--A Decision Whose Time Has Come. Washington, D.C.: U.S. Government Printing Office, 1971, 188.

196. Dupree, A. Hunter. Science and the Emergence of Modern America, 1865-1916. Chicago: Rand McNally, 1963, 59.

197. ________. Science in the Federal Government: A History of Policies and Activities to 1940. Cambridge, Massachusetts: Harvard University Press, 1957, 460.

198. Federation of Rocky Mountain States, Inc., and the Western Governors Conference. Public Science Policy: Background Reading, Western States Conference on Science and Technology and Its Application to Problems of Pollution, Transportation and Employment. Denver, Colorado: Federation of Rocky Mountain States, Inc., and the Western Governors Conference, 1970, 134.

199. Feller, I., J. P. Nelson, R. S. Friedman, and J. M. Mead. State Organization of Research and Development: A Case Study, Commonwealth of Pennsylvania. University Park: Pennsylvania State University, Institute for Research on Human Resources, Center for the Study of Science Policy, 1970, 254.

200. Fortune. Great American Scientists: America's Rise to the Forefront of World Science. Englewood Cliffs, New Jersey: Prentice-Hall, 1961, 144.

201. Gellhorn, Walter. Security, Loyalty, and Science. Ithaca, New York: Cornell University Press, 1950, 300.

202. George Washington University. Program of Policy Studies in Science and Technology. A Critical Review of the Marine Science Commission Report. Washington, D.C.: George Washington University, 1969, 94.

203. Gilman, William. Science: U.S.A. New York: Viking Press, 1965, 499.

204. Glass, H. Bentley, ed. Life Sciences in Space. Report of the Study to Review NASA Life Sciences Programs Convened by the Space Science Board, National Academy of Sciences - National Research Council. Washington, D.C.: National Academy of Sciences, 1970, 51.

205. Goldstein, Kenneth K., ed. California Science: A Reporter's View. New York: Institute for the Study of Science in Human Affairs, 1970, 72.

206. Greenberg, Daniel S. The Politics of Pure Science. New York: New American Library, 1967, 303.

207. Haberer, Joseph. Politics and the Community of Science. New York: Van Nostrand Reinhold, 1969, 337.

208. Hewlett, Richard G. and Francis Duncan. Atomic Shield, 1947-1952: Volume II of a History of the United States Atomic Energy Commission. University Park: Pennsylvania State University Press, 1969, 718.

209. Hindle, Brooke. The Pursuit of Science in Revolutionary America, 1735-1789. Chapel Hill: University of North Carolina Press, 1956, 410.

210. ________. Technology in Early America: Needs and Opportunities for Study. Chapel Hill: University of North Carolina Press, 1966, 145.

211. Lilienthal, David E. The Journals of David E. Lilienthal. Volume II: The Atomic Energy Years, 1945-1950. New York: Harper and Row, 1964, 666.

212. Lindveit, Earl W. Scientists in Government. Washington, D.C.: Public Affairs Press, 1960, 85.

213. McCamy, James L. Science and Public Administration. University, Alabama: University of Alabama Press, 1960, 218.

214. Macy, Bruce W., James M. Bednar, and Robert E. Roberts. Impact of Science and Technology on Regional Development. Report prepared for the Office of Regional Development Planning, U.S. Department of Commerce. Kansas City, Missouri: Midwest Research Institute, 1967, 168.

215. Manning, Thomas G. Government in Science: The U.S. Geological Survey, 1867-1894. Lexington: University of Kentucky Press, 1967, 257.

216. Marine Science Affairs--Selection Priority Programs. Annual Report of the President to the Congress on Marine Resources and Engineering Development, April, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 284.

217. March, Paul E. and Ross A. Gortner. Federal Aid to Science Education: Two Programs. Syracuse, New York: Syracuse University Press, 1963, 97. (The Economics and Politics of Public Education, No. 6)

218. Miller, Howard S. Dollars for Research: Science and Its Patrons in Nineteenth-Century America. Seattle: University of Washington Press, 1970, 258.

219. Mock, James E., ed. Science for Society. Proceedings of the National Science Conference on Goals, Policies, and Programs of Federal, State, and Local Science Agencies. Atlanta, Georgia: Georgia Science and Technology Commission, 1970, 193.

220. Montana. Science, Technology, and State Government in Montana. Proceedings of a Seminar Series conducted by the Governor's Interim Committee on Science and Technology in cooperation with the National Science Foundation. Bozeman: Montana State University, 1971, 162.

221. National Academy of Sciences. Applied Science and Technological Progress: A Report to the Committee on Science and Astronautics, U.S. House of Representatives. Washington, D.C.: National Academy of Sciences, 1967, 434.

222. ________. Science, Government, and the Universities. Seattle and London: University of Washington Press, 1966, 116.

223. National Academy of Sciences. National Academy of Engineering. The Impact of Science and Technology on Regional Economic Development. Washington, D.C.: National Academy of Sciences, 1969, 112.

224. National Academy of Sciences - National Research Council. Committee on Science and Public Policy. Federal Support of Basic Research in Institutions of Higher Learning. Washington, D.C.: National Academy of Sciences - National Research Council, 1964, 98. (Publication 1185)

225. National Academy of Sciences - National Research Council. Advisory Committee on Government Programs in the Behavioral Sciences. The Behavioral Sciences and the Federal Government. Washington, D.C.: National Academy of Sciences, 1968, 107.

226. National Aeronautics and Space Administration. America's Next Decades in Space: A Report for the Space Task Group. Washington, D.C.: NASA, 1969, 84.

227. National Science Foundation. Conference Proceedings, Midwest Regional Conference on Science, Technology, and State Government. Sponsored by the National Science Foundation, the Department of Health, Education, and Welfare, and the State of Illinois, held at Arlington Heights, Illinois, November 17-19, 1970. Washington, D.C.: National Science Foundation, 1970, 271.

228. ________. Employment of Scientific and Technical Personnel in State Government Agencies: Report on a 1959 Survey. Part I: Employment of Scientific and Technical Personnel by Occupation. Part II: Employment of Scientific and Technical Personnel by Type of Agency. Washington, D.C.: U. S. Government Printing Office, 1961, 67.

229. ________. Organization of the Federal Government for Scientific Activities. Washington, D.C.: U.S. Government Printing Office, 1962, 598.

230. ________. Research and Development in Local Governments, Fiscal Years 1968 and 1969. Surveys of Science Resources Series. Washington, D.C.: National Science Foundation, 1971, 55. (NSF 71-6)

231. ________. Research and Development in State Government Agencies, Fiscal Years 1967 and 1968. Surveys of Science Resources Series. Washington, D.C.: U.S. Government Printing Office, 1970, 93. (NSF 70-22)

232. ________. Science, Technology, and State Government. Proceedings of the NSF-SINB Conference, September, 1920, 1969, Louisville, Kentucky, 1969. Washington, D.C.: National Science Foundation, 1969, 238.

233. ________. Scientific Activities in Six State Governments: Summary Report on a Survey, Fiscal Year 1954. Washington, D.C.: U.S. Government Printing Office, 1958, 62. (NSF 58-24)

234. National Science Foundation Science Policy Task Force and the Southern Interstate Nuclear Board. Advancing Regional Development Through Science and Technology. Atlanta, Georgia: Southern Interstate Nuclear Board, 1971, 185.

235. Nelson, Richard, et al. Technology, Economic Growth, and Public Policy. Washington, D.C.: Brookings Institution, 1967, 238.

236. New York State Science and Technology Foundation. Report of the New York State Science and Technology Foundation. Albany, New York: New York State Science and Technology Foundation, 1970, 16.

237. Oklahoma Task Force for Science and Technology Policy Structure. Science and Technology and the State of Oklahoma: A Report to the Governor of the State of Oklahoma. Oklahoma City: Frontiers of Science Foundation of Oklahoma, 1971, 11.

238. Oliver, John W. History of American Technology. New York: Ronald Press, 1956, 676.

239. Organization for Economic Cooperation and Development. Directorate for Scientific Affairs. Reviews of National Policies for Science and Education: Higher Education and the Demand for Scientific Manpower in the United States. Paris: OECD, 1963, 102.

240. ______. Directorate for Scientific Affairs. Reviews of National Science Policy: Canada. Paris: OECD, 1969, 453.

241. ______. Directorate for Scientific Affairs. Reviews of National Science Policies: United States. Paris: OECD, 1968, 622.

242. Orlans, Harold. Contracting for Atoms: A Study of Public Issues Posed by the Atomic Energy Commission's Contracting for Research, Development, and Managerial Services. Washington, D.C.: Brookings Institution, 1967, 242.

243. ______. The Effects of Federal Programs on Higher Education: A Study of Thirty-Six Universities and Colleges. Washington, D.C.: Brookings Institution, 1962, 361.

244. Ostrander, Gilman M. American Civilization in the First Machine Age: 1890-1940. New York: Harper and Row, 1970, 414.

245. Padelford, Norman J. Public Policy for the Seas. Revised Edition. Cambridge, Massachusetts and London: M.I.T. Press, 1970, 338.

246. Pennsylvania State University. State Science Activities, Papers and Discussion. University Park: Institute for Research on Human Resources, Pennsylvania State University, 1970, 77.

247. Piccard, Paul J., ed. Science and Policy Issues: Lectures in Government and Science. Itasca, Illinois: F. E. Peacock, 1969, 156.

248. Pollard, William G. Atomic Energy and Southern Science. Oak Ridge, Tennessee: Oak Ridge Associated Universities, 1966, 140.

249. Price, Don K. Government and Science: Their Dynamic Relation in American Democracy. New York: New York University Press, 1954, 203.

250. ______. The Scientific Estate. Cambridge, Massachusetts: Harvard University Press, 1965, 323.

251. Pursell, Carroll W., Jr., ed. Readings in Technology and American Life. New York: Oxford University Press, 1969, 470.

252. Reagan, Michael D. Science and the Federal Patron. New York: Oxford University Press, 1968, 346.

253. Reingold, Nathan, ed. Science in Nineteenth Century America. New York: Hill and Wang, 1964, 339.

254. Rockefeller University. Proceedings of the New York State-Federal Science and Technology Conference. Albany, New York: New York State Public Service Commission, 1970, 64.

255. Rogers, W. P. U.S. Foreign Policy in a Technological Age. Washington, D.C.: U.S. Government Printing Office, 1971, 12.

256. Rosholt, Robert L. An Administrative History of NASA, 1958-1963. Washington, D.C.: National Aeronautics and Space Administration, 1966, 381.

257. Ruckelshaus, William D. Reality before Rhetoric in the Environmental Movement. Washington, D.C.: Office of Public Affairs, Environmental Protection Agency, 1971, 12.

258. Schaffter, Dorothy. The National Science Foundation. New York: Praeger, 1969, 278.

259. Seaborg, Glenn T. Science and Our Society. Washington, D.C.: U.S. Atomic Energy Commission, 1966, 99.

260. Seaborg, Glenn T. and Daniel M. Wilkes. Education and the Atom. New York: McGraw-Hill, 1964, 150.

261. Seitz, Frederick. The Relationship between Science and Government. Houston, Texas: Robert A. Welch Foundation, 1965, 26.

262. Servan-Schreiber, Jean-Jacques. The American Challenge. New York: Atheneum, 1968, 291.

263. Seymour, S. Frederick, ed. Washington Colloquium on Science and Society. First Series. Baltimore: Mono Book Corporation, 1967, 181.

264. Smith, Alice K. A Peril and a Hope: The Scientist's Movement in America 1945-1947. Chicago: University of Chicago Press, 1965, 591.

265. Smith, Bruce L. R. The RAND Corporation. Cambridge, Massachusetts: Harvard University Press, 1966, 430.

266. Smithsonian Institution. Managing the Environment: Nine States Look for New Answers. Washington, D.C.: Woodrow Wilson International Center for Scholars, Smithsonian Institution, 1971, 445.

267. Spangler, M. B. New Technology and Marine Resource Development. New York: Praeger, 1970, 607.

268. Steelman, John R. Science and Public Policy. U.S. President's Scientific Research Board. A Report to the President. Washington, D.C.: U.S. Government Printing Office, 1947.
Volume I : A Program for the Nation, 73.
Volume II : The Federal Research Program, 318.
Volume III: Administration for Research, 324.
Volume IV: Manpower for Research, 166.
Volume V : The Nation's Medical Research, 118.

269. Stover, Carl F. The Government of Science: A Report to the Center for the Study of Democratic Institutions. Santa Barbara, California: Center for the Study of Democratic Institutions, 1962, 47.

270. Strout, Cushing, ed. Conscience, Science, and Security: The Case of Dr. J. Robert Oppenheimer. Chicago: Rand McNally, 1963, 58.

271. Struik, Dirk J. Yankee Science in the Making. Boston: Little, Brown, 1948, 430.

272. Tennessee: Governor's Science Advisory Committee. Science, Technology, and the State Government. Knoxville: Center for Business and Economic Research, College of Business Administration, University of Tennessee, 1971, 87.

273. Thistle, Mel. The Inner Ring: The Early History of the National Research Council of Canada. London: Oxford University Press, 1966, 435.

274. Tybout, Richard A. Government Contracting in Atomic Energy. Ann Arbor: University of Michigan Press, 1956, 226.

275. Underwood, J. E. Science/Technology-Related Activities in the Government of New York State: The Organizational Pattern. Albany, New York: New York State Education Department, 1971, 112.

276. United Nations Educational, Scientific, and Cultural Organization. National Science Policies of the U.S.A.: Origins, Development, and Present Status. Paris: UNESCO, 1968, 170.

277. U.S. Atomic Energy Commission. Major Activities in the Atomic Energy Programs, January-December, 1967. Washington, D.C.: U.S. Atomic Energy Commission, January, 1968, 397.

278. U.S. Commission on Marine Science, Engineering, and Resources. Panel Reports of the Commission on Marine Science, Engineering, and Resources; Volume 1: Science and Environment; Volume 2: Industry and Technology; Volume 3: Marine Resources and Legal-Political Arrangements for Their Development. Washington, D.C.: U.S. Commission on Marine Science, Engineering, and Resources, February, 1969, 1106.

279. U.S. Congress. House. Marine Science Affairs--Selecting Priority Programs. Annual Report of the President to Congress on Marine Resources and Engineering Development together with Report of National Council on Marine Resources and Engineering Development, 91st Congress, 2nd Session, April, 1970. House Document 91-304. Washington, D.C.: U.S. Government Printing Office, 1970, 284.

280. U.S. Congress. House. Our Nation and the Sea: Plan for National Action. Report of the President's Commission on Marine Science, Engineering, and Resources to the 91st Congress, 1st Session, January, 1969. House Document 91-42. Washington, D.C.: U.S. Government Printing Office, 1969, 305.

281. ________. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Development. Science, Technology, and American Diplomacy: A Selected Annotated Bibliography of Articles, Books, Documents, Periodicals, and Reference Guides. Prepared for the Subcommittee by Franklin P. Huddle, Science Policy Research and Foreign Affairs Divisions, Congressional Research Service, Library of Congress, 91st Congress, 2nd Session, April, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 69.

282. ________. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Development. Science, Technology, and American Diplomacy: Toward a New Diplomacy in a Scientific Age. Prepared for the Subcommittee by Franklin P. Huddle, Science Policy Research and Foreign Affairs Divisions, Congressional Research Service, Library of Congress, 91st Congress, 2nd Session, April, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 28.

283. ________. Committee on Government Operations. Subcommittee on Executive and Legislative Reorganization. Reorganization Plan No. 3 of 1970 (Environmental Protection Agency). Hearings before the Subcommittee to the 91st Congress, 2nd Session, July 22, 23, and August 4, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 209.

284. ________. Committee on Government Operations. Subcommittee on Executive and Legislative Reorganization. Reorganization Plan No. 4 of 1970 (National Oceanic and Atmospheric Administration). Hearings before the Subcommittee to the 91st Congress, 2nd Session, July 28-29, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 164.

285. ________. Committee on Government Operations. Subcommittee on Military Operations. Science Organizations in the Executive Office of the President. Washington, D.C.: U.S. Government Printing Office, 1967, 326.

286. ________. Committee on Merchant Marine and Fisheries. Subcommittee on Fisheries and Wildlife Conservation. Council on Environmental Quality. Hearings before the Subcommittee to the 91st Congress, 2nd Session, March 5 and August 12, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 166.

287. U.S. Congress. House. Committee on Merchant Marine and Fisheries. Subcommittee on Oceanography. Oceanography in the 90th Congress. Prepared for the Subcommittee by George A. Doumani, Science Policy Research Division, Legislative Reference Service, Library of Congress, 91st Congress, 1st Session, January 10, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 84.

288. ________. Committee on Merchant Marine and Fisheries. Subcommittee on Oceanography. Sea Grant College Program. Hearings before the Subcommittee to the 90th Congress, 2nd Session, March 14, 1968. Washington, D.C.: U.S. Government Printing Office, 1968, 37.

289. ________. Committee on Science and Astronautics. Amending the National Science Foundation Act of 1950 to Make Improvements in the Organization and Operation of the Foundation. House Report 1650 of the Committee to accompany House Report 14838 to the 89th Congress, 2nd Session, June 23, 1966. Washington, D.C.: U.S. Government Printing Office, 1966, 54.

290. ________. Committee on Science and Astronautics. Creation of the Office of Science and Technology (Reorganization Plan No. 2, 1962). Prepared for the Committee by Dorothy Schaffter and Dorothy M. Bates, Legislative Reference Service, Library of Congress, 87th Congress, 2nd Session, May 15, 1962. Washington, D.C.: U.S. Government Printing Office, 1962, 85.

291. ________. Committee on Science and Astronautics. Report on the Activities of the Committee on Science and Astronautics, Ninety-First Congress, First and Second Sessions. Report of the Committee to the 91st Congress, 1st and 2nd Sessions, December 31, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 20.

292. ________. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Centralization of Federal Science Activities. Report prepared for the Subcommittee by the Science Policy Research Division, Legislative Reference Service, Library of Congress, 91st Congress, 2nd Session, May 29, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 108.

293. ________. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Government and Science. No. 1: A Statement of Purpose. Report of the Subcommittee to the 89th Congress, 1st Session, December 2, 1963. Washington, D.C.: U.S. Government Printing Office, 1963, 14.

294. U.S. Congress. House. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. The National Institutes of Research and Advanced Studies--A Recommendation for Centralization of Federal Science Responsibilities. Report of the Subcommittee to 91st Congress, 2nd Session, April 15, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 55.

295. ______. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. National Science Policy. Hearings before... 91st Congress, 2nd Session, July 7-September 17, 1970 on H. Con. Res. 666. Washington, D.C.: U.S. Government Printing Office, 1970, 963.

296. ______. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Policy Issues in Science and Technology: Review and Forecast. Third Progress Report of Subcommittee to 90th Congress, 2nd Session, October 28, 1968. Washington, D.C.: U.S. Government Printing Office, 1968, 54.

297. ______. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Summary of Activities of the Subcommittee on Science, Research and Development, 1963-1970. Report of the Subcommittee to 91st Congress, 2nd Session. Washington, D.C.: U.S. Government Printing Office, 1970, 83.

298. ______. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Technical Information for Congress. Report of the Subcommittee to 92nd Congress, 1st Session, April 15, 1971, prepared by the Science Policy Research Division, Congressional Research Service, Library of Congress. Washington, D.C.: U.S. Government Printing Office, 1971, 845.

299. ______. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Toward a Science Policy for the United States. Report of... 91st Congress, 2nd Session, October 15, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 115.

300. U.S. Congress. Senate. Committee on Aeronautical and Space Sciences. Space Cooperation between the United States and the Soviet Union. Hearing before... 92nd Congress, 1st Session, March 17, 1971. Washington, D.C.: U.S. Government Printing Office, 1971, 30.

301. U.S. Congress. Senate. Committee on Government Operations. Subcommittee on Executive Reorganization and Government Research. Federal Role in Health. Senate Report 91-809 of the Subcommittee to the 91st Congress, 2nd Session, April 30, 1970 (pursuant to Senate Resolution 320). Washington, D.C.: U.S. Government Printing Office, 1970, 561.

302. ________. Committee on Government Operations. Subcommittee on Executive Reorganization and Government Research. An Inventory of Congressional Concern with Research and Development, 91st Congress, 1969-1970, Part V. Prepared for the Subcommittee by Barbara A. Luxenberg, Congressional Research Service, Library of Congress, 91st Congress, 2nd Session. Washington, D.C.: U.S. Government Printing Office, 1971, 64.

303. U.S. Department of Commerce. National Bureau of Standards. U.S. Metric Study Report International Standards. Interim Report. Washington, D.C.: U.S. Government Printing Office, 1970, 157. (NBS SP 345-1)

304. ________. National Oceanic and Atmospheric Administration. The National Oceanic and Atmospheric Administration Fact Sheet. Washington, D.C.: U.S. Government Printing Office, 1970, 11.

305. U.S. Federal Council for Science and Technology. U.S. Civil Service Commission. Proceedings--Third Symposium: The Environment of the Federal Laboratory, December 7-8, 1964. Washington, D.C.: U.S. Government Printing Office, 1965, 125.

306. U.S. National Council on Marine Research and Engineering Development. Details of Five-Point Interim Marine Science Program. Washington, D.C.: U.S. Government Printing Office, 1969, 5.

307. U. S. Office of the Oceanographer of the Navy. The Ocean Science Program of the U.S. Navy: Accomplishments and Prospects. Washington, D.C.: U.S. Government Printing Office, 1970, 99.

308. U.S. Office of Science and Technology. Federal Council for Science and Technology, 1969 Annual Report. Washington, D.C.: U.S. Government Printing Office, 1969, 29.

309. U.S. President's Science Advisory Committee. Scientific Progress, the Universities, and the Federal Government: A Statement. (The Seaborg Report). Washington, D.C.: U.S. Government Printing Office, 1960, 33.

310. ________. The Space Program in the Post-Apollo Period: A Report of the President's Science Advisory Committee. Prepared by the Joint Space Panels. Washington, D.C.: U.S. Government Printing Office, 1967, 99.

311. ________. Panel on Oceanography. Effective Use of the Sea. Washington, D.C.: U.S. Government Printing Office, 1966, 144.

312. U.S. President's Task Force on Science Policy. Science and Technology: Tools for Progress. Washington, D.C.: U.S. Government Printing Office, 1970, 48.

313. Van Tassel, David D. and Michael G. Hall. Science and Society in the U.S. Homewood, Illinois: Dorsey Press, 1966, 290.

314. Weaver, Warren. Science of Change: A Lifetime in American Science. New York: Scribner's, 1970, 226.

315. Wells, J. G., et al. Contract Research and Development Adjuncts of Federal Agencies: An Exploratory Study of Forty Organizations. Denver, Colorado: Denver Research Institute, University of Denver, 1969, 400. (PB 187 945)

316. Wengert, Norman, ed. Perspectives in Government and Science. Philadelphia: American Academy of Political and Social Science, 1960, 204.

317. Whitnah, David R. A History of the United States Weather Bureau. Urbana: University of Illinois Press, 1961, 267.

318. Wolfle, Dael. Science and Public Policy. Lincoln: University of Nebraska Press, 1959, 81.

LEADING QUESTIONS

1. How has science been involved in American politics? In foreign policy? In domestic policy?

2. What are the principal organizational components for scientific and technological decision-making in the Federal government? What are their statutory and functional relationships? Are advisory and decision-making functions realistically separable?

3. What were the principal observations of the OECD examination of science policy in the United States (1968)? What response has been made to the observations of the examiners?

4. What difficulties has the American politician encountered in attempts to deal with issues having science content? How could these difficulties be alleviated?

5. What difficulties complicate the role of the Congress in the formulation and review of science policy? What methods, proposed or in effect, have been advanced to assist the Congress in decisions relating to science policy?

6. What has been the role of the National Academy of Sciences-National Research Council in the administration of federal science policy? What circumstances led to the establishment of the National Academy of Engineering? Why are the social sciences largely excluded from the NAS?

7. What are the arguments for and against a national department of science and technology? Is there a parallel in the proposals for a national university?

8. How did establishment of the national system of land grant colleges mark a change in the functions of universities and the beginning of a new era in relationships between government, higher education, and industry?

9. What has been the role of privately owned industry in the organization and development of American science? What appears to be its probable future? How do not-for-profit R&D organizations differ, in addition to financial status, from other private industrial enterprises?

10. What role have State governments played in the development of science and technology? Is there any correlation between the quality of State government generally and its role in science and technology?

TOPIC 07 SCIENCE AND GOVERNMENT: THE SOVIET UNION

The distinguishing characteristic of Russian science has been its centralized and governmentalized character. From the time of its introduction from Western Europe by Czar Peter I, until given its present structure under the Soviet regime, science in Russia has been almost exclusively a governmental function. The structure of Soviet science, although not monolithic, is nevertheless subject to overall political and fiscal control. Soviet science is thus amenable to integrated and programed direction. It may, however, lack the flexibility and creativity of less highly structured Western science.

The Academy of Sciences was planned by Peter I and established in 1725. Initial membership of the Academy (16) was foreign. Nearly a century was required for it to become a truly Russian institution. In 1847, university functions were removed from the Academy, establishing the practice of separating research, which the Academy retained, from instruction, which was the principle function of the universities.

The autocratic and ideologically dominated governments of the Czars and the Soviets favored science insofar as it served their purposes. They had little interest in the freedom of science and did not hesitate to punish scientists for political heresies. The safest sciences in Russia were the most abstract. It is not suprising therefore that Russian scientists distinguished themselves especially in the physical sciences and mathematics.

Politcal domination of Soviet science reached its greatest extent under the dictatorship of Joseph Stalin. The most notorious political-scientific controversy of the Stalin era arose over the theories of genetics associated with the biologist Lysenko. His views, although rejected by most biologists, were favored by the political authorities. Lysenko's academic opponents suffered political reprisals. The episode gave the name "Lysenkoism" to efforts to make scientific theory conform to politcal ideology.

Coordination of Soviet science policy takes place in committees of the Council of Ministers of the U.S.S.R., notably in the State Committee for Coordination of Research and Development. Principal components of the Soviet system for science policy are the Academies of Science (of the U.S.S.R. and Union Republics), the Ministry of Higher and Secondary Specialized Education, and ministerial and industrial committees for research and development planning.

Science and technology have been accorded high priority in the allocation of public resources. Scientists and engineers are among the more prominent members of a new Soviet professional class, which Marxist ideology opposes but which practical considerations abet. It remains to be seen whether the strength of Soviet science can be channeled indefinitely along ideological lines. As social and behavioral science advances in other parts of the world, the Soviet commitment to a social ideology beyond challenge by science may be severely strained.

TOPIC 07 SCIENCE AND GOVERNMENT: THE SOVIET UNION

Selected Basic Readings:

Amann, R. "The Soviet Research and Development System: The Pressures of Academic Tradition and Rapid Industrialisation," Minerva, VIII (April, 1970), 217-241.

Gill, Richard R. "Decision-making in Soviet Science Policy," Bulletin of the Atomic Scientists, XXIV (April, 1968), 15-19.

Jordan, Lloyd F. "Scientific and Technical Relations among Eastern Communist Countries," Minerva, VIII (July, 1970), 376-395.

Kapitza, Peter L. "Problems of Soviet Scientific Policy," Minerva, IV (Spring, 1966), 391-397.

OECD Observer. "Science Policy in the U.S.S.R.," OECD Observer, Number 38 (February, 1969), 10-14.

Supplementary and Substitute Readings:

Joravsky, David. "The Lysenko Affair," Scientific American, CCVII (November, 1963), 41-49.

Medvedev, Zhores A. "The Closed Circuit--A Record of Soviet Scientific Life," Nature, CCXXVII (September 19, 1970), 1197-1202.

Sakharov, Andrei D. Progress, Coexistence, and Intellectual Freedom. New York: Norton, 1968, 158.

Vuchinich, Alexander A. "Science and Morality: A Soviet Dilemma," Science, CLIX (March 15, 1968), 1208-1212.

Zaleski, E. "Soviet R & D: Finance and Allocation," Science and Technology, Number 89 (May, 1969), 8-15.

Zvorykin, A. A. "The Organization of Scientific Work in the U.S.S.R.," Impact of Science on Society, XV (Number 2, 1965), 67-118.

TOPICAL OUTLINE | REFERENCE KEY

I. Science in Czarist Russia — 154, 155

A. Influence of Western thought in the 17th century
1. Receptivity of Czars and court officers
2. Opposition of Orthodox clergy
3. Development of non-theoretical technical knowledge

B. Peter I, 1682-1725, and the beginning of Russian science
1. Role of foreign scientists and advisers
   a. Leibniz, science counselor to Peter the Great
   b. Henry Farquharson and the School of Mathematics and Navigation, 1701 (after 1715, Naval Academy)
   c. Influence of the European academies: common characteristics of voluntary assemblages of scholars for the advancement of knowledge (not teaching); contrasts in concepts of the relation of scientific academies to the state; "nationalist" science in France and Prussia
2. The St. Petersburg Academy of Sciences, 1725 — 48
   a. Initial membership--foreign scholars (13 German, 2 Swiss, 1 French)
   b. Functions indicated in plan approved in 1724 by Peter I; Academicians were to:
      (1) engage in independent research in their disciplines
      (2) prepare extracts from foreign scientific publications
      (3) collectively evaluate inventions submitted to them for appraisal
      (4) provide expert answers to questions propounded by governmental authorities

(5) prepare Latin and Russian textbooks in their fields

c. Absence of universities a handicap. 21

d. Charter of 1847 separates Academy from university functions and excludes the humanities from the Academy

e. Contentions between:

(1) Academicians and bureaucratic control

(2) Russians and West Europeans

f. Influence and accomplishments of the early Academy

3. University of Moscow founded, 1755

C. Russian science in the 19th and early 20th centuries 21, 154, 155

1. Flowering of an indigenous Russian science after 1860: Butlerov, Sechenov, Mendeleev, Pavlov, Tsiolkovsky

2. Shifting attitudes in the Russian government toward science and higher education--indirectly encouraging the already traditional emphasis on mathematics, physical science, and technology and discouraging social science, law, and evolutionary aspects of biology

II. Science, Marxism, and the Russian Revolution of 1918 107, 110, 116, 121, 129

A. Marxism as a "scientific theory" of social evolution 101

B. Incompatibility of open-ended science and closed-system dogma--the inevitability of conflict between Marxist ideology and biological and social science 10, 65, 75, 131, 133, 151, 161

C. Utilitarian tendency of Soviet science policy with resulting:	62, 98, 112
1. Centralized direction of scientific work	
2. Emphasis on technology	
D. Politicization of Soviet science under Stalin	13, 51, 72, 99, 104, 106, 160
1. Totalitarian impact of Soviet science	7, 22, 27, 30, 38, 63
2. Lysenkoism	31, 35, 36, 37, 66, 118, 132, 161
E. De-Stalinization of Soviet science--limits on political feasibility in an ideological state	27, 49, 94, 155, 159
F. Comparison of Soviet and Czarist science policies--similarities and apparent contrasts	98
III. The Institutional Structure of Contemporary Soviet Science	1, 2, 3, 14, 15, 19, 25, 44, 52, 71, 89, 100, 105, 119, 122, 136, 149, 150
A. The Academy of Sciences of the U.S.S.R	29, 48, 76, 120, 151, 156
1. Role and status of Soviet science	104
2. Academies in the Union Republics	79
3. The Science City at Novo Sibirsk (Akademgorodok)	8, 40, 54, 79, 81
B. Administrative apparatus for science and technology	1, 83, 90, 126, 135, 140
1. Council of Ministers of the U.S.S.R.	
a. State Planning Committee (Gosplan)	
b. State Economic Council of the Council of Ministers	

c. State Committee on the Coordination of Research and Development, Council of Ministers	
2. Ministry of Higher and Secondary Specialized Education of the U.S.S.R. (and Union Republic Ministries, and Committees of Higher and Secondary Specialized Education)	113
3. Ministries and administrations with special scientific or technical functions: e.g., Ministry of Health, Academy of Medical Sciences; Ministry of Geology and Mineral Resources, Administration of Hydrometeorological Services	
4. State committees with research and development functions, e.g., Automation and Machine Building, Atomic Energy, Radio-Electronics	24, 45, 103, 123, 127
C. The role of institutions of higher education	108, 109, 113
D. Relations between the U.S.S.R. and the East European socialist countries in the fields of science and technology, e.g. COMECON.	4, 28, 39, 40, 55, 67, 68, 77, 82, 144, 145, 150
IV. Trends and Prospects for Science and Technology in the Soviet Technological Society	5, 6, 18, 58, 59, 64, 69, 74, 88, 103, 114, 115, 117, 120, 123, 128, 130, 136, 143, 146, 149, 157
A. Rise of a new class--scientific and technical professions in the U.S.S.R.	12, 38, 42, 47, 86, 93, 95, 106, 109, 111, 138, 147
B. Dilemma of Soviet science policy--risks of deviation or stultification	13, 60, 99, 101, 102, 119, 129, 137
C. Soviet policy in relation to international scientific cooperation--problems of outflanking the ideological barrier;	11, 142

1. Exchange programs and visitations — 9, 53, 61
2. Cooperative international efforts, e.g., Antarctica, outer space — 152, 158

D. Strengths and weaknesses in Soviet policy toward science and technology — 13, 23, 41, 70, 80, 91, 119, 140

1. Emphasis on research rather than development — 17
2. Long "lead times" between innovation and production — 17
3. Orientation of economic planning towards achievement of maximum production, often neglecting experimentation
4. Existence of organizational barriers between different phases of the research-production cycle:
   a. Between fundamental and other types of research
   b. Between civilian and military R&D: strong barriers due to secrecy as well as organizational distinctiveness
   c. Between industries: individual ministries have their own industry-related R&D program
   d. Between industrial research and the producing enterprise: network of specialist establishments separated geographically and organizationally
5. Experimentation with new organizational forms:
   a. Factory center in which research institution, design bureaus and production enterprises are brought together in a single unit
   b. Research complexes closely associated with industry, e.g., Leningrad Polytechnical Institute
   c. Self-supporting research corporations which work for industry
   d. Science cities — 8, 26, 43, 47, 57, 73, 85

BIBLIOGRAPHY

General References: Articles

1. Adamson, R. "Mobilizing of Soviet Science," Scientific Research, II (January 27, 1968), 24-34.

2. Amann, R. "The Soviet Research and Development System: The Pressures of Academic Tradition and Rapid Industrialisation," Minerva, VIII (April, 1970), 217-241.

3. Bawn, D. E. "Some Impressions of Soviet Science," American Scientist, XLVIII (March, 1960), 46-50.

4. Biernacki, Andrzej. "Observations on the Development of Science in Poland," Minerva, VI (Autumn, 1967), 18-27.

5. Boretsky, Michael. "Comparative Progress in Technology, Productivity, and Economic Efficiency--U.S.S.R. versus U.S.A.," in New Directions in the Soviet Economy, Studies Prepared for the Subcommittee on Foreign Economic Policy of the Joint Economic Committee, Congress of the United States. 89th Congress, 2nd Session. Washington, D.C.: U.S. Government Printing Office, 1966, 133-256.

6. Brownlow, C., and B. Miller, eds. "The Growing Threat--1: Soviet Union's Technological-Military Drive," Aviation Week and Space Technology, XCV (October 4, 1971), 12-15; "The Growing Threat--2: Soviets Stressing Offensive Mix of Strategic Arms for which U.S. Has Little Defense," Ibid. (October 11, 1971), 36-41.

7. Chappell, John E. "Marxism and Geography," Problems of Communism, XIV (November-December, 1965), 12-22.

8. Clarke, Robin. "Akademgorodok: Eastern Centre for Western Science," Science Journal, III (August, 1967), 81-86.

9. Clemens, Walter C. "Sakharov: A Man For Our Times," Bulletin of the Atomic Scientists, XXVII (December, 1971), 4-6; 51-56.

10. Cole, Michael. "Psychology: A Checkered Course," Problems of Communism, XIV (November-December, 1965), 47-55.

11. Dedijer, Stevan. "Soviets Take a New Look at Science," Bulletin of the Atomic Scientists, XXI (March, 1965), 40-41.

12. DeWitt, Nicholas. "High Level Manpower in the U.S.S.R.," in New Directions in the Soviet Economy, op. cit., 789-816.

13. ________. "The Politics of Soviet Science," American Behavioral Scientist, VI (December, 1962), 7-11.

14. ________. "Reorganization of Science and Research in the U.S.S.R.," Science, CXXXII (June 23, 1961), 1981-1991.

15. ________. "Soviet Science: The Institutional Debate," Bulletin of the Atomic Scientists, XVI (June, 1960), 208-211.

16. Dobzhansky, Theodosius. "Commentary by American Geneticists," Bulletin of the Atomic Scientists, V (May, 1949), 141-143; 146.

17. Dornberg, J. "Russia's Technological Gap Widening," Congressional Record, CXVII (March 11, 1971), E1813-E1814.

18. Emelyanov, V. S. "Nuclear Energy in the Soviet Union," Bulletin of the Atomic Scientists, XXVII (November, 1971), 38-41.

19. Encel, S. "Science and Government Policy--III: The Soviet Union," Public Administration [Australia], XXV (June, 1966), 104-114.

20. Field, Mark G. "Soviet Science and Some Implications for American Science and Society," Journal of International Affairs, XIII (Number 1, 1959), 19-33.

21. Figurovsky, N. A. "The Interaction between Scientific Research and Technical Invention in the History of Russia," in Scientific Change: Historical Studies in the Intellectual, Social, and Technical Conditions for Scientific Discovery and Technical Invention, Antiquity to the Present, ed. by A. C. Crombie, New York: Basic Books, 1963, 701-723.

22. Gardner, Martin. "'Bourgeois Idealism' in Soviet Nuclear Physics," Yale Review, XLIII (March, 1954), 386-399.

23. Gill, Richard R. "Decision-making in Soviet Science Policy," Bulletin of the Atomic Scientists, XXIV (April, 1968), 15-19.

24. Gillette, Robert. "Nuclear Power in the U.S.S.R.: American Visitors Find Surprises," Science, CLXXIII (September 10, 1971), 1003-1006.

25. ________. "The Soviet Space Program: Effort Said to Surpass Peak U.S. Level," Science, CLXXV (February 18, 1972), 731-736.

26. Gould, Donald. "Russian Flowers Bloom," New Scientist, XXXIV (June 15, 1967), 636-637.

27. Graham, Loren R. "A Soviet Marxist View of Structural Chemistry: The Theory of Resonance Controversy," Isis, LV (March, 1964), 20-31.

28. Groszkowski, Janusz. "The Style of Poland's Research," International Science and Technology, Number 25 (January, 1964), 35-39.

29. Guine, George C. "The Academy of Sciences of the U.S.S.R.," Russian Review, XII (October, 1953), 269-271.

30. Hollitscher, Walter. "Dialectical Materialism and the Physicist," Bulletin of the Atomic Scientists, IX (March, 1953), 54-57.

31. Huxley, Julian. "Soviet Genetics: The Real Issue," Nature, CLXIII (June 18, 1949), 935-942.

32. Joint Publications Research Service. "Effectiveness of Science and Its Achievements, U.S.S.R.," [Selected Articles], (September 5, 1969). Washington, D.C.: U.S. Government Printing Office, 1969, 23.

33. ________. "Effects of Engineering Psychology: Examination of Technical Progress in the U.S.S.R." Translated from Rabochay Gazeta (June 24, 1969). Washington, D.C.: U.S. Government Printing Office, 1969, 17.

34. ________. "News of Scientific Activities and Organizations, U.S.S.R." Washington, D.C.: U.S. Government Printing Office, 1968, 37.

35. Joravsky, David. "The Debacle of Lysenkoism," Problems of Communism, XIV (November-December, 1965), 2-12.

36. ________. "The Lysenko Affair," Scientific American, CCVII (November, 1963), 41-49.

37. Joravsky, David. "Soviet Marxism and Biology before Lysenko," Journal of the History of Ideas, XX (January, 1959), 85-104.

38. ________. "Soviet Scientists and the Great Break," Daedalus, LXXXII (Summer, 1960), 562-581.

39. Jordan, Lloyd F. "Coordinated Planning for Science in Communist Europe," Science, CLV (February 17, 1967), 796-802.

40. ________. "Scientific and Technical Relations among Eastern Communist Countries," Minerva, VIII (July, 1970), 376-395.

41. Kapitza, Peter L. "Problems of Soviet Scientific Policy," Minerva, IV (Spring, 1966), 391-397.

42. ________. "The Scientist and the Plans," Minerva, IV (Summer, 1966), 555-560.

43. Kaprowski, Hilary, et al. "A New Science City in Siberia," Science, CXLIX (August 27, 1965), 947-949.

44. Kozloski, J.P. "R&D in the U.S.S.R.," Science and Technology, Number 87 (March, 1969), 10-19.

45. Kramish, Arnold. "The Atom and the Soviet Union," Industrial Research, VI (May, 1964), 56-65.

46. Krauskopf, Konrad B. "Report on Russia: Geochemistry and Politics," Science, CXXXIV (August 25, 1961), 539-542.

47. Lavrent'ev, A. Mikhail. "700,000 Scientists in the U.S.S.R. in 1967," UNESCO Courier, XX (November, 1967), 31-37.

48. Lipski, A. "The Foundation of the Russian Academy of Sciences," Isis, XLIV (December, 1953), 349-354.

49. London, Ivan D. "De-Stalinization in Soviet Physiology," Science, CXXXVIII (October 5, 1962), 16-17.

50. ________. "The Scientific Council on Problems of the Physiological Theory of Academician I. P. Pavlov: A Study in Control," Science, CXVI (July 11, 1952), 23-27.

51. London, Ivan D. "Toward a Realistic Appraisal of Soviet Science," Bulletin of the Atomic Scientists, XIII (May, 1957), 169-173; 176.

52. Low, Ian. "A Sketch of Soviet Science," New Scientist, XXV (February 25, 1965), 504-505.

53. McElheny, Victor K. "East-West Exchanges of Technology Increase Rapidly," Science, CLIII (July 8, 1966), 156-158.

54. __________. "Science Center in Siberia," Science, CLII (May 20, 1966), 1047.

55. Maksimovic, D. M. "Yugoslavia--Development of Scientific Research," Nature, CCXVIII (June 1, 1968), 846-849.

56. Margerison, Tom. "A Report on Science in Russia Today," New Scientist, II (November 14, 1957), 10-11.

57. __________. "Russia's New Plan to Decentralize Science," New Scientist, III (March 27, 1958), 10-11.

58. Marshak, Robert E. "Nature of the Soviet Scientific Challenge," Bulletin of the Atomic Scientists, XIV (February, 1958), 83-86.

59. __________. "Reexamining the Soviet Scientific Challenge," Bulletin of the Atomic Scientists, XIX (April, 1963), 12-17.

60. __________. "Scientific Research in the Soviet Union," Science, CXXIV (December 7, 1956), 1125-1127.

61. Medvedev, Zhores A. "The Closed Circuit--a Record of Soviet Scientific Life," Nature, CCXXVII (September 19, 1970), 1197-1202.

62. Mikhailov, A. "The Organization of Scientific Work in the U.S.S.R.," American Review of the Soviet Union, VIII (March, 1947), 26-35.

63. Mikulak, Maxim W. "Soviet Cosmology and Communist Ideology," Scientific Monthly, LXXXI (October, 1955), 167-172.

64. Minerva. "Scientific Policy in the U.S.S.R.," Minerva, IV (Winter, 1966), 215-230.

65. Moore, Barrington, Jr. "Recent Developments in the Social Sciences in the Soviet Union," American Sociological Review, XII (June, 1947), 349-351.

66. Muller, Hermann J. "The Crushing of Genetics in the U.S.S.R.," Bulletin of the Atomic Scientists, IV (December, 1948), 369-371.

67. Nature. "Poland: Where Science Stands Now," Nature, CCXXXI (May 28, 1971), 226-227.

68. Nekola, J. and J. Zelinka. "Research and Development in Czechoslovakia," Minerva, VI (Spring, 1968), 388-397.

69. Nelson, Bryce. "Soviet Science: OECD Reports a Pattern of Uneven Development," Science, CLXIII (February 28, 1969), 917-918.

70. Nove, A. "Soviet Research Problems," New Scientist, XXVII (January 11, 1968), 84-85.

71. OECD Observer. "Science Policy in the U.S.S.R.," OECD Observer, Number 38 (February, 1969), 10-14.

72. Oster, G. "Scientific Research in the U.S.S.R.," Annals of the American Academy of Political and Social Science, CCLXIII (May, 1949), 134-140.

73. Parry, Albert. "Akademgorodok--That Science City in Siberia," Industrial Research, V (December, 1963), 30-34.

74. Petrov, B. "Targets for Soviet Space Research," New Scientist and Science Journal, L (May 6, 1971), 308-310.

75. Polanyi, Michael. "The Autonomy of Science," Scientific Monthly, LX (February, 1945), 141-150.

76. Rabinowitch, Eugene. "Soviet Academy of Sciences," Bulletin of the Atomic Scientists, XVII (December, 1961), 441-442.

77. Rakovic, Branko. "Scientific Policy in Yugoslavia," Minerva, III (Winter, 1965), 187-209.

78. Ratuszniak, Zygmunf. "The System," Polish Perspectives, IX (December, 1966), 5-14.

79. Salomon, S. N. "A Year in Siberian Science," Technology Review, LXXIII (July-August, 1971), 10-11.

80. Science. "Defector's Odyssey: Personal Look at Soviet-Bloc Science Provided by High-Ranking German Physicist," Science, CXLIX (July 2, 1965), 40-42.

81. ________. "What the French President Saw: A Gallic View of Novosibirsk," Science, CLIII (July 1, 1966), 45-46.

82. Segal, G. "Has COMECON Missed the Revolution?" New Scientist and Science Journal, LI (August 5, 1971), 310-311.

83. Senior, D. A. "The Organization of Scientific Research," in The State of Soviet Science, ed. by the Editors of Survey: A Journal of Soviet and East European Studies. Cambridge, Massachusetts: M.I.T. Press, 1965, 19-35.

84. Shcherban, A. "Science Serves the People," Impact of Science on Society, XII (1962), 119-134.

85. Shelton, William R. "Science in Siberia," Bulletin of the Atomic Scientists, XXVII (February, 1971), 23-28.

86. Shimkin, Demitri. "Scientific Personnel in the U.S.S.R.," Science, CXVI (November 7, 1952), 512-513.

87. ________. "The Structure of Soviet Power," Quarterly Review of Economics and Business, III (Autumn, 1963), 19-24.

88. Siforov, V. I. "Long-Range Forecasting of Scientific and Technical Progress, U.S.S.R.," from Radiotekhnika, no. 5, 1969. Joint Publications Research Service, Washington, D.C.: U.S. Government Printing Office, 1969, 7.

89. Sikolnikoff, I. S. "Organized Research in the U.S.S.R.," Scientific Monthly, LXXII (March, 1951), 164-168.

90. Swanson, James M. "Reorganization: 1963," in The State of Soviet Science, ed. by the Editors of Survey: A Journal of Soviet and East European Studies. Cambridge, Massachusetts: M.I.T. Press, 1965, 36-40.

91. Tokaty, G. A. "Soviet Rocket Technology," Technology and Culture, IV (Fall, 1963), 515-528.

92. Turkevich, John. "The Progress of Soviet Science," Foreign Affairs, XXXII (April, 1954), 430-439.

93. ______. "The Scientist in the U.S.S.R.," Atlantic Monthly, CCI (January, 1958), 45-49.

94. ______. "Soviet Science in the Post-Stalin Era," Annals of the American Academy of Political and Social Science, CCCIII (January, 1956), 139-151.

95. ______. "The Soviet's Scientific Elite," Saturday Review of Literature, XXXIX (March 24, 1956), 60-62.

96. Vavilov, S. "Science for the People," Soviet Russia Today, (September, 1947), 19.

97. Vladimirov, Leonid. "Soviet Science--A Native's Opinion," New Scientist, XL (November 28, 1968), 488-490.

98. Vuchinich, Alexander A. "The Ethos of Soviet Science," Pacific Spectator, IX (Summer, 1955), 332-344.

99. ______. "Science and Morality: A Soviet Dilemma," Science, CLIX (March 15, 1968), 1208-1212.

100. Walsh, Warren B. "Soviet Research Priorities: Exercises in Forecasting," American Behavioral Scientist, VIII (December, 1964), 3-6.

101. Wetter, Gustav S.J. "Ideology and Science in the Soviet Union: Recent Developments," Daedalus, LXXXIX (Summer, 1960), 581-603.

102. White, S. "Science v. the Bureaucrats," New Scientist and Science Journal, LI (July 29, 1971), 252-253.

103. Zaleski, E. "Soviet R & D: Finance and Allocation," Science and Technology, Number 89 (May, 1969), 8-15.

104. Zirkle, Conway. "The Involuntary Destruction of Science in the U.S.S.R.," Scientific Monthly, LXXVI (May, 1953), 277-283.

105. Zvorykin, A. "The Organization of Scientific Work in the U.S.S.R.," Impact of Science on Society, XV (Number 2, 1965), 67-118.

General References: Books

106. Askby, Eric. Scientist in Russia. New York: Penguin Books, 1947, 252.

107. Christman, Ruth C., ed. Soviet Science. Washington, D.C.: American Association for the Advancement of Science, 1952, 108.

108. DeWitt, Nicholas. Education and Professional Employment in the U.S.S.R. Prepared for the National Science Foundation by the Office of Scientific Personnel, National Academy of Sciences-National Research Council. Washington, D.C.: National Science Foundation, 1961, 856.

109. Engineers Joint Council. The Training, Placement, and Utilization of Engineers and Technicians in the Soviet Union. New York: Engineers Joint Council, 1961, 101.

110. Fischer, George. Science and Politics: The New Sociology in the Soviet Union. Ithaca, New York: Center for International Studies, Cornell University, 1964, 65.

111. Fischer, George, ed. Science and Ideology in Soviet Society. New York: Atherton Press, 1967, 176.

112. Fyodorov, Y. Science in the U.S.S.R. Moscow: Foreign Language Publishing House, 1964, 58.

113. Galkin, K. The Training of Scientists in the Soviet Union. Moscow: Foreign Languages Publishing House, 1959, 203.

114. Gilzin, Karl A. Sputniks and After. Translated by Pauline Rose. London: MacDonald, 1959, 285.

115. Gouschev, Sergei and Mikhail Vassiliev, eds. Russian Science in the 21st Century. New York: McGraw-Hill, 1960, 222.

116. Graham, Loren. The Soviet Academy of Sciences and the Communist Party, 1927-1932. Princeton, New Jersey: Princeton University Press, 1967, 255.

117. Heymann, Hans. The U.S.S.R. in the Technological Race. Santa Monica, California: RAND Corporation, 1959, 15.

118. Huxley, Julian. Heredity, East and West: Lysenko and World Science. New York: Henry Schuman, 1949, 246.

119. Joint Publications Research Service. Academy of Sciences of the U.S.S.R., a Brief Account of Its History and Work, ed. by O. M. Karpenko. Washington, D.C.: U.S. Government Printing Office, 1969, 171.

120. ________. Philosophical Problems of Forecasting and Organizing U.S.S.R. Science. Washington, D.C.: U.S. Government Printing Office, 1969, 98.

121. Joravsky, David. Soviet Marxism and Natural Science, 1917-1933. New York: Columbia University Press, 1961, 433.

122. Juviler, Peter H. and Harry W. Morton, eds. Soviet Policy-Making: Studies of Communism in Transition. New York: Praeger, 1967, 274.

123. Kacinskas, Leonas. Cybernetics in the U.S.S.R. Washington, D.C.: Library of Congress, Aerospace Technology Division, 1969, 69.

124. Kassof, Allen. Prospects for Soviet Society. New York: Praeger, 1967, 600.

125. Korol, Alexander. Soviet Education for Science and Technology. Cambridge, Massachusetts: M.I.T. Press; New York: Wiley, 1957, 513.

126. ________. Soviet Research and Development: Its Organization, Personnel, and Funds. Cambridge, Massachusetts: M.I.T. Press, 1965, 375.

127. Kramish, Arnold. Atomic Energy in the Soviet Union. Stanford, California: Stanford University Press, 1959, x, 232. Biblio.

128. Kreiger, F. J. Behind the Sputniks: A Survey of Soviet Space Science. Washington, D.C.: Public Affairs Press, 1958, 380.

129. Kurakov, I.G. Science, Technology, and Communism: Some Questions of Development. Trans. from the Russian. Oxford: Pergamon, 1966, 126.

130. McKinney, Robert. The Red Challenge to Technological Renewal in the West. Santa Fe, New Mexico: New Mexico Press, 1960, 24.

131. Medvedev, Zhores A. The Medvedev Papers: The Plight of Soviet Science Today. Trans. by Vera Rich. New York: St. Martin's Press, 1971, 472.

132. ________. The Rise and Fall of T.D. Lysenko. Trans. by I.M. Lerner. New York: Columbia University Press, 1969, 284.

133. Medvedev, Zhores A. and Roy A. Medvedev. A Question of Madness. Trans. by Ellen de Kadt. New York: Knopf, 1971, 224.

134. National Academy of Sciences-National Research Council. Office of the Foreign Secretary. The Eastern European Academies of Sciences: A Directory. Washington, D.C.: National Academy of Sciences-National Research Council, 1963, 148. (Pub. 1090)

135. Nimitz, Nancy. Soviet Expenditures on Scientific Research. Santa Monica, California: RAND Corporation, 1963, 64.

136. Organization for Economic Cooperation and Development. Science Policy in the U.S.S.R. Paris: OECD, 1969, 165.

137. Parry, Albert. The New Class Divided: Science and Technology versus Communism. New York: Macmillan, 1966, 364.

138. ________. Peter Kapitsa on Life and Science. New York: Macmillan, 1968, 271.

139. Penkovskiy, Oleg. The Penkovskiy Papers. Garden City, New York: Doubleday, 1965, 411.

140. Ploss, Sidney I. Conflict and Decision-Making in Soviet Russia: A Case Study of Agricultural Policy, 1953-1963. Princeton, New Jersey: Princeton University Press, 1965, 312.

141. Pokrovsky, G. I. Science and Technology in Contemporary War. Trans. by Raymond L. Garthoff. New York: Praeger, 1959, 180.

142. Sakharov, Andrei D. Progress, Coexistence, and Intellectual Freedom. New York: Norton, 1968, 158.

143. Shelton, William. Soviet Space Exploration: The First Decade. New York: Washington Square Press, 1968, 339.

144. Slamecka, Vladimir. Science in Czechoslovakia. New York: Columbia University Press, 1963, 175.

145. ________. Science in East Germany. New York: Columbia University Press, 1963, 124.

146. Survey: A Journal of Soviet and East European Studies, the Editors of The State of Soviet Science. Cambridge, Massachusetts: M.I.T. Press, 1965, 209.

147. Turkevich, John. Soviet Men of Science: Academicians and Corresponding Members of the Academy of Sciences of the U.S.S.R. Princeton, New Jersey: Van Nostrand, 1963, 411.

148. United Nations Educational, Scientific, and Cultural Organization. Science Policy and Organization of Scientific Research in the Czechoslavakian Socialist Republic. Paris: UNESCO, 1965, 88.

149. ________. Science Policy and the Organization of Scientific Research in the Socialist Federal Republic of Yugoslavia. Paris: UNESCO, 1968, 124. (Science Policy Studies and Documents, No. 9)

150. ________. Science Policy and Organization of Research in the U.S.S.R. Paris: UNESCO, 1967, 116.

151. ________. The Social Science Activities of Some Eastern European Academies of Sciences. Paris: UNESCO, 1963, 61.

152. U.S. Congress. Senate. Aeronautical and Space Sciences Committee. Soviet Space Programs, 1962-1965; Goals and Purposes, Achievements, Plans, and International Staff Report. Review by Glen P. Wilson for the Committee to the 89th Congress, 2nd Session, December 30, 1966. Washington, D.C.: U.S. Government Printing Office, 1967, 920.

153. ________. Committee on Government Operations. Subcommittee on National Security Staffing and Operations. Staffing Procedures and Problems in the Soviet Union. A Study Submitted by the Subcommittee to the 88th Congress, 1st Session, May 15, 1963. Washington, D.C.: U.S. Government Printing Office, 1963, 62.

154. Vuchinich, Alexander A. Science in Russian Culture--A History to 1860. Stanford, California: Stanford University Press, 1963, 463.

155. ________. Science in Russian Culture, 1861-1917. Stanford, California: Stanford University Press, 1970, 576.

156. ________. The Soviet Academy of Science. Stanford, California: Stanford University Press, 1956, 157.

157. White, Sarah, ed. Guide to Science and Technology in the U.S.S.R. Guernsey, British Channel Islands: Francis Hodgson, 1971, 500.

158. Wukelic, George E., ed. Handbook of Soviet Space-Science Research. New York: Gordon and Breach, 1968, 505.

159. Zaleski, Eugene, et al. Science Policy in the U.S.S.R. Paris: Organization for Economic Cooperation and Development, 1969, 615.

160. Zirkle, Conway. Evolution, Marxian Biology, and the Social Scene. Philadelphia: University of Pennsylvania Press, 1959, 527.

161. Zirkle, Conway, ed. Death of a Science in Russia: The Fate of Genetics as Described in Pravda and Elsewhere. Philadelphia: University of Pennsylvania Press, 1949, 319.

Addendum:

162. Gol'danskiy, V.I., V.A. Kirillin, et al. "Future of Science, U.S.S.R.," The Future of Science, (October, 1971).

163. Greenberg, Linda Lubrano. "Soviet Science Policy and the Scientific Establishment," Survey, Number 4 (Autumn, 1971), 51-63.

164. Gurvich, F.G. "Symposium on Research Planning and Management, U.S.S.R.," Economics and Mathematical Methods, V (November, 1971).

165. Keldysh, M.V. "Research Plans of U.S.S.R. Academy of Sciences," Science and Life, VIII (December, 1971).

166. Lomov, B., V. Rubakhin, and G. Sukhodol'skiy. "Problem of Man and Technology, U.S.S.R.," Socialist Labor, V (October, 1971).

167. Science and Life. "Scientific Management of Society, U.S.S.R.," Science and Life, IV (November, 1971).

168. Vucinich, Alexander. Science in Russian Culture, 1861-1917. Stanford, California: Stanford University Press, 1970, 575.

LEADING QUESTIONS

1. What are the principal organizational differences between American and Russian education and research in scientific and technical fields?

2. To what extent were technological and scientific ideas influential in pre-revolutionary Russia? What effect, for instance, did the work of D.I. Mendeleev, K.E. Tsiolkovsky, I.P. Pavlov, and Count Witte have upon the character of Russian science and technology?

3. To what extent did a "two-culture" circumstance prevail in pre-revolutionary Russian intellectual life?

4. What were the historical origins of the distinctions between the Russian universities, the technological institutes, and the academies? What is the role of the Academy of Sciences of the U.S.S.R.?

5. What was "Lysenkoism"? What was its history? Have there been parallel developments in the United States? In other countries?

6. What has been the evidence of a decentralization of scientific and technological work in the U.S.S.R. since World War II? Has the decentralization been general or selective?

7. How does public regard for scientists and engineers differ as between the U.S.A. and U.S.S.R.? What factors appear to account for the differences?

8. How has the U.S.S.R. used science as an instrument of foreign policy? How would you appraise the effectiveness of this effort?

9. Why have such observers as James Burnham and Jacques Ellul pointed to the Soviet Union as the most advanced form of technological society? Are national industrial systems generally moving toward or away from the Soviet model? What is the evidence?

10. Do the ideological parameters that circumscribe Soviet science seem likely ultimately to force it into an intellectual cul-de-sac? Will the scientific technology upon which Communist leaders have set such store ultimately contribute to the dissolution of the Marxist-Leninist regime? (Note opinions expressed by Stevan Dedijer--reference)

TOPIC 08 THE ORGANIZATION OF SCIENCE IN WESTERN EUROPE

The historical development of government-science relationships in Western Europe has followed two contrasting patterns. Prototypes for these general patterns are found in England, where a laissez faire attitude toward science long prevailed, and in France, where government has been the principal patron and organizer of science. These patterns are no longer clearly defined, and there are many variations and intermediate stages in other European nations. But the tendency among the civil law states of continental Europe has been to follow the French system of centralized, government-sponsored science; whereas in the United Kingdom and the smaller maritime states of northwest Europe the relationships between government and science were similar to those also prevailing in the United States. The basis for these differences has lain not so much in attitudes toward science as in prevailing concepts of jurisprudence and public administration. Similar contrasts may be found with regard to governmental responsibility for education, economic affairs, and the fine arts.

The chartering of the Royal Society in London in 1662 marks the beginning of organized science in England. During the 18th and 19th centuries a modified laissez faire prevailed with respect to science and technological innovation. England was a leader in the industrial revolution and it was industrial technology, encouraged by the inducements of a market economy, that flourished. Not until mid-twentieth century did the British government become seriously involved in science policy. In the post-World War II era, science became a political issue, and major innovations occurred in government organization.

In France, government sponsorship of science may be said to have begun with the establishment of L'Academie des Sciences in 1666. Advancement of science and technology, at least in theory, became a continuing function of French government. In the years between World Wars I and II the vigor of French science appeared to decline, and in 1958 a major reorganization of the machinery of government for the advancement of science and technology occurred. An effort has been made to preserve the advantages of centralized support and coordination and to gain flexibility and diversity, involving the industrial sector and the research laboratories and university faculties in partnership in planning.

The period since World War II has been marked by a resurgence of science in Germany, which had suffered heavy losses during the Hitler regime and the war years. European regional cooperation for science and technology has greatly increased. Adding to the informal collaboration of individual scholars and scholarly societies, new organizations have been established for cooperation in atomic energy (CERN, EUROCHEMIC, EURATOM) and space research (ESRO and ELDO). The high cost of advanced scientific research and technological innovation makes international cooperation a practical necessity in many fields of inquiry for most European states.

TOPIC 08 THE ORGANIZATION OF SCIENCE IN WESTERN EUROPE

Selected Basic Readings:

Flowers, Brian. "Science and the Common Market," Nature, CCXXXIII (September 17, 1971), 173-176.

Nature. "France: At the Crossroads," Nature, CCXXXI (May 28, 1971), 229-230.

OECD Observer. "Technological Gaps: Their Nature, Causes, and Effects," OECD Observer, Number 33 (April, 1968), 18-28.

Valery, N. "Germany's Science Boom Gets Underway," New Scientist and Science Journal, L (May 20, 1971), 471-472.

Wedgewood Benn, Anthony. "Science, Europe, and a New World," New Scientist and Science Journal, XLIX (February 18, 1971), 348-350.

Supplementary and Substitute Readings:

Huntley, J.R. "Gaps in the Future: The American Challenge and the European Challenge," Futures, II (March, 1970), 5-14.

Industrial Research. "Special Report on R & D in Europe," Industrial Research, XIV (January, 1972), 28-49.

Nature. "Survey of Science in Europe," Nature, CCXXXI (May 28, 1971), 221-236.

OECD Observer. "Science Policy in Germany and the United Kingdom," OECD Observer, Number 24 (October, 1966), 30-34.

Piganoil, Pierre. "Scientific Policy and the European Community," Minerva, VI (Spring, 1968), 354-365.

Quinn, James B. "National Planning of Science and Technology in France," Science, CL (November 19, 1965), 993-1003.

TOPICAL OUTLINE	REFERENCE KEY
I. Historical Roots of Science in the West (cf. Topic 02)	6, 117, 130
A. Science in the Middle Ages--legacy of antiquity	
B. Birth of modern science in the Renaissance	
1. Patronage of science	
2. Science in the universities	
C. Emergence of organized science (Cf. Topic 04)	296
1. Independent scientific societies, e.g., The Royal Society of London, 1662	289, 302
2. Government-sponsored academies, e.g., L'Académies des Sciences, 1666; The Royal Observatory at Greenwich, 1675; academies established in Prussia, 1700; Sweden, 1739; Denmark, 1742; Netherlands, 1808; Austria, 1847	206, 266, 334
D. Science and technology as instruments of national policy	220, 274
1. The place of science and technology in political economy: mercantilists statisticians, cameralists, physiocrats.	306
2. Establishment of institutions for higher education in science and technology, e.g., Ecole Polytechnique in France, 1794; and the Federal Institute of Technology in Zurich, 1854	130, 354
II. Science and Government in the United Kingdom	113, 130, 139, 159, 174, 197, 199, 207, 210, 276, 279, 300, 301, 304, 320

A. Historical relations of government to science--modified *laissez faire*	213, 233, 283, 289, 302
1. The Baconian tradition--The New Atlantis, 1626	296
2. The Royal Society	141, 172, 173, 188, 195, 216, 273
3. The British Association for the Advancement of Science, 1832	150, 194, 235
4. The National Physical Laboratory, 1900	155, 202
B. Science and technology in the Industrial Revolution	175, 275
1. The role of invention	286
2. Interrelations between science and industry	286
3. Influence of the relations among science, technology, and industry in shaping popular concepts of science in English-speaking countries	
C. Science during World War I and between the World Wars	268, 269
1. Realization during the first World War of the unity of scientific knowledge which supports both the military and the industrial effort Recognition of need to put state support of science on something more than an ad hoc basis	
2. Establishment of science advisory committees and the beginning of an integrated science policy	
3. The Haldane Committee of the Privy Council (1915), which became the Department of Scientific and Industrial Research (1916)	203, 261
4. The 'Million Fund' and the Research Associations set up to support scientific research	187
5. The Report of the Haldane Committee on the Machinery of Government (1918) resulted in the creation of a Ministry of Health, and a Medical Research Council (1920). An Agricultural Research Council was established in 1931	307, 312

6. A professional organization--the National Union of Scientific Workers was established in 1918, which became the Association of Scientific Workers in 1927
7. The Tizard Committee for the Scientific Study of Air Defense (1934) led to the development of radar

D. Science during and after World War II — 130, 140, 153, 179, 219, 228, 253, 281, 288, 293, 301, 314, 320, 321

1. Mobilization of British science during World War II. Cooperation with the U.S. in the development of the atomic bomb, and the large scale manufacture of penicillin — 280
2. Attempt to apply methodology of the natural sciences to improvement of efficiency of war led to a new branch of applied science--Operations Research
3. Science as a postwar political issue — 131, 161, 215, 229, 241, 247, 251, 319
4. Science as an intellectual issue — 114, 130, 162, 303
   a. The Two Cultures controversy (Cf. Topic 05)
   b. Reform in higher education--
      (1) The Robbins Commission
      (2) The Open University — 138, 148, 160, 163, 166, 167, 169, 181, 205, 222, 230, 237, 249, 257, 264
5. Restructuring of government for science policy — 131, 143, 158
6. Scientific manpower and the effects of the "Brain Drain" — 149, 168, 176, 183, 204, 226, 240, 245, 252, 254, 271, 298, 315, 316
7. The British atomic energy and space programs — 159, 192, 196, 200, 209, 221, 250, 267, 272
8. Research and development in industry — 152, 243, 260, 308, 320

E. The structure for the administration of science and technology in the United Kingdom	146, 184, 225, 236, 248, 253, 263, 277, 290, 297, 319
1. Higher education	144, 147, 156, 201, 211, 242, 259, 278, 287, 309, 311, 318
2. Research councils and institutes	164, 165, 178, 255, 265, 282, 310, 317
3. Parliament (The Parliamentary and Scientific Committee, 1939)	139, 151, 208, 238, 270
4. The ministerial structure.	123, 197, 258, 373
a. The Scientific Civil Service, 1949	
b. The Science and Technology Act of 1964	
c. Department of Education and Science	
d. Ministry of Technology, 1964-1970	154, 157, 171, 185, 191, 224
e. Council for Scientific Policy	
f. Committee on Manpower Resources for Science and Technology	
g. Department of the Environment	256, 317
5. National Research and Development Corporation	186, 227, 313
III. Science and Government in France	323, 330, 346, 348, 351
A. Science and rationalism during the era of Louis XIV: emergence of a pattern of state-science relationships--etatism	337
B. Science and the French Revolution	324, 326, 354
C. Science-government relationships in the 19th and 20th centuries to 1945	323, 335, 355
D. Rejuvenation of French science and technology after 1945	327, 344, 353

1. Role of science in the "modernization" of post-war France
2. Commissariat a l'Energie Atomique (CEA), 1945 — 331, 336, 338, 339, 349, 350
3. Landucci Report, 1957
4. Decree of 28 November 1958
5. The space program — 322
6. Research and development in industry — 329, 352

E. The structure of administration for science and technology in France — 340, 345, 346, 348
   1. The educational system--teaching and research — 333, 352
      a. New role for universities
      b. Engineering schools: The Grands Ecoles (e.g., Ecole Polytechnique, 1794) — 342
      c. National Center for Scientific Research, CNRS
      d. The Institute of Science and Technology at Lyons — 328
   2. The ministerial structure — 345
      a. Minister-Delegate, Scientific Research and Atomic and Space Questions
      b. Interministerial Committee for Scientific and Technical Research
      c. Consultative Committee on Scientific and Technical Research
      d. General Delegation for Scientific and Technical Research, DGRST
      e. Commissariat du Plan
   3. Science and technology in the post-de Gaulle era — 343
      a. Ministry for Industrial and Scientific Development — 325, 332
      b. Ministry for the Protection of Nature and the Environment

IV. Science and Government in Germany — 356, 370, 372, 373, 383

A. Early development of government patronage of science	
1. Berlin Academy of Science	
2. Statistics	
B. Preeminence of German science in the 19th and early 20th centuries--The Kaiser Wilhelm Society	374
C. Decline of German science after World War I and the debacle of Nazism and World War II	116, 358, 359, 364, 365, 375
D. Reorganization of science in the Federal Republic of Germany	123, 369, 371, 372, 383
1. Science Council--Wissenshaftsrat, 1957	362
2. Joint Federal-Lander (State) Committee for Science	
3. Federal Ministry of Nuclear Energy, 1955, which became the Federal Ministry for Scientific Research in 1962, and the Ministry of Science and Education in 1969	
4. Cabinet and Interministerial Committees for Scientific Research	
5. Committees for Scientific and Cultural Affairs in both houses of the federal legislature	
6. Structure of research and development	367, 383
a. German Research Association (DFG)	
b. Max Planck Society (MPG)	361, 380, 386
c. University Research Institutes	361, 363, 381
d. Independent and state-supported research institutes, such as the Volkswagen Foundation, the Fritz Thyssen Foundation, the Donor's Association for Promoting Arts and Sciences, Berlin Science Center	
7. The Federation of Industrial Research Associations	383
E. Re-emergence of a strong technoscientific enterprise in Germany--emphasis on	366, 368, 376, 384, 385
1. The atomic energy program	382

2. The German Research Organization for Air and Space Travel — 360
3. Data processing and information technology — 360

V. Science and Government in the Other Nations of Western Europe — 35, 68, 91, 134, 135, 136, [illegible] 387, [illegible]

VI. European Scientific Enterprise--International Regional Organization (see also Topic 09) — 8, 15, 24, 35, 36, 66, 67, 68, 86, 91, 107, 121, 134, 135, 136

A. The trans-national character of European science — 1, 6

B. The establishment of international institutes and organizations for scientific investigation

1. International Congresses after 1847
2. International associations and bureaus
   a. Universal Society of Ophthalmology--Paris, 1861
   b. European Association of Geodesy--Berlin, 1866
   c. Zoological Station of Naples, 1870
   d. International Bureau of Weights and Measures--Paris, 1875
   e. Jungfraujoch Scientific Station, 1930

C. The effects of the cold war and atomic and space science on European cooperation — 1, 54, 55, 84, 137

1. General structures for cooperation
   a. Organization for Economic Cooperation and Development, OECD, 1948, 1960 — 41, 66, 74
   b. Council of Europe, 1949
   c. North Atlantic Treaty Organization, NATO, 1949--Committee on Challenges of Modern Society — 25, 70, 71, 72, 106

European Coal and Steel Community, ECSC, 1951	
e. Nordic Council, Nordforsk, and NORDOK	416, 419, 422
2. Nuclear energy	30, 65, 80, 81, 87, 125
a. European Organization for Nuclear Research, CERN, 1953	2, 48, 102
b. European Company for the Chemical Processing of Irradiated Fuel, EUROCHEMIC, 1957	
c. European Nuclear Energy Agency, ENEA, 1957	73
d. Halden Reactor, HALDEN, 1958 (boiling water reactor, Norway)	104
e. Dragon Reactor, DRAGON, 1959 (gas-cooled reactor, U.K.)	104
f. European Atomic Energy Committee, EURATOM, 1959	3, 23, 33, 66
g. Uranium centrifuge	27
3. Space research	5, 11, 13, 51
a. European Space Research Organization, ESRO, 1962	12, 50, 62, 98
b. European Launcher Development, ELDO, 1962	10, 14, 52, 62

D. Other European cooperative institutions for science and technology

1. Western European Union, WEU, 1948	
2. European Organization for Experimental Photogrammetric Research, OERPE, 1953	
3. European Atomic Energy Society, EAES, 1954	
4. European Organization for Research on Flourine and Dental Caries, ORCA, 1953	
5. European Federation of Chemical Engineering, 1953	
6. European Molecular Biology Organization, EMBO	9, 18, 39, 65, 108
7. European Cell Biology Organization	63
8. European Physical Society	97

E. Nature and causes of the "Technology Gap" between Europe and the U.S.A.--extent of the "gap" in, for example, the electronics, computer, and pharmaceutical industries	19, 20, 21, 34, 37, 40, 44, 56, 58, 75, 76, 77, 78, 83, 99, 103, 109, 110, 122, 130, 136
F. Problems of multi-national science cooperation in Western Europe--proposals for new ways of collaborating	82, 101, 118, 120, 127
1. European Research Council	32
2. International Institute for the Management of Technology	7, 26, 38, 66
3. European Science Foundation	79
4. Individual projects, such as the British-French supersonic transport	22, 95, 111

BIBLIOGRAPHY

General References: Articles

1. Auger, Pierre. "Scientific Cooperation in Western Europe," Minerva, I (Summer, 1963), 428-438.

2. Bakker, C. J. "CERN as an Institute for International Cooperation," Bulletin of the Atomic Scientists, XVI (February, 1960), 54-57.

3. Barnaby, F. "EURATOM--The Sick Leading the Six?" New Scientist and Science Journal, XLIX (February 18, 1971), 356-357.

4. Boffey, Philip M. "Technology and World Trade: Is There Cause for Alarm?" Science, CLXXII (April 2, 1971), 37-41.

5. Bolkow, L. "A Future for European Aerospace?" New Scientist and Science Journal, XLIX (February 18, 1971), 352-353.

6. Born, Max. "Europe and Science," Bulletin of the Atomic Scientists, XIV (February, 1958), 73-79.

7. Cade, J. A. "The International Institute for the Management of Technology," OECD Observer, Number 47 (August, 1970), 44-49.

8. Caty, G. "Coordination of European Science and Technology," Science Policy News, (September, 1969), 25-30.

9. Chedd, G. "A New Lab for Europe?" New Scientist and Science Journal, XLIX (February 18, 1971), 350-352.

10. Coleman, H. J. "British Withdrawing from ELDO," Aviation Week and Space Technology, LXXXVIII (April 22, 1968), 16-17.

11. Croome, A. "Europe Still Awaits Space Decisions," Science Journal, Va (October, 1969), 6-7.

12. ________. "ESRO: The Next Decade," New Scientist, XL (December 19, 1968), 662-663.

13. Edelson, E. "Gloom in the Space Lobbies," New Scientist, XL (October 24, 1968), 179-180.

14. Fink, D. E. "Failure Clouds European Launcher Future," Aviation Week and Space Technology, XCV (November 15, 1971), 20-21.

15. Flowers, Brian. "Science and the Common Market," Nature, CCXXXIII (September 17, 1971), 173-176.

16. Gates, D. M. "Basic Research in Europe," Science, CXXVIII (August 1, 1958), 227.

17. Gibbons, Michael. "The CERN 300 GeV Accelerator: A Case Study in the Application of the Weinberg Criteria," Minerva, VIII (April, 1970), 180-191.

18. Gillie, O. "Molecular Biology: Growth Pangs in Europe," Science Journal, Va (September, 1969), 11; 13; 15.

19. Gilpin, Robert. "Of Course the Gap's Not Really Technological," The Public Interest, Number 12 (Summer, 1968), 124-129.

20. Grevashev, V. and A. Davydov. "Discussions on Europe's Scientific and Technical Progress," International Affairs, VII (July, 1968), 46-51.

21. Goldstein, Walter. "Europe Faces the Technology Gap," Yale Review, LIX (Winter, 1970), 161-178.

22. Greenberg, Daniel S. "Concorde: The Costs Are Rising, But So Are Prospects for Success," Science, CLXV (July 25, 1969), 374-377.

23. ________. "EURATOM: Atomic Agency Foundering amidst Squabbles of Its Partners," Science, CLXIII (February 7, 1969), 552-553.

24. ________. "European Science: Financially, Politically, It Has Trouble Too," Science, CLXVI (November 28, 1969), 1122-1126.

25. ________. "NATO: Scientific Affairs Division a Miniature NSF for the Alliance," Science, CLXIII (February 28, 1969), 915-917.

26. ________. "Son of Technology Gap: European Group Setting Up an Institute," Science, CLXVII (February 6, 1970), 850-852.

27. ________. "Uranium: Three European Nations Plan To Build Centrifuge Plants," Science, CLXIV (April 4, 1969), 53-55.

28. Grant, R. P., C. P. Huttrer, and C. G. Metzner. "Biomedical Science in Europe," Science, CXLVI (October 23, 1964), 493-501.

29. Grossfield, Karl. "National Interest Aspects of Innovation," Advancement of Science, XXV (March, 1969), 335-343.

30. Gueron, J. "Atomic Energy in Continental Western Europe," Bulletin of the Atomic Scientists, XXVI (June, 1970), 62-68; 116.

31. ________. "The Lack of Scientific Planning in Europe," Bulletin of the Atomic Scientists, XXV (October, 1969), 10-14; 25.

32. Hawkes, N. "New Approach to European Collaboration," Science Journal, Va (November, 1969), 11; 13.

33. Hirsch, Etienne. "A Guide to EURATOM," Bulletin of the Atomic Scientists, XV (June, 1959), 250-252; 265.

34. Huntley, J.R. "Gaps in the Future: The American Challenge and the European Challenge," Futures, II (March, 1970), 5-14.

35. Industrial Research. "Special Report on R & D in Europe," Industrial Research, XIV (January, 1972), 28-49.

36. Jahsman, W. H. "Toward a European Scientific Power," Technology Review, LXXIII (June, 1971), 10-12.

37. Jequier, Nicolas. "Technological Gaps in the Computer Industry," OECD Observer, Number 40 (June, 1969), 31-37.

38. Kendall, Maurice. "A European Institute of Technology?" New Scientist, XXXVII (February 8, 1968), 296-297.

39. Kendrew, J. C. "EMBO and the Idea of a European Laboratory," Nature, CCXVIII (June 1, 1968), 840-842.

40. King, Alexander. "Closing the Technology Gap," Nature, CCXVIII (June 1, 1968), 815-818.

41. ________. "Science and Education in OECD," OECD Observer, Special Issue on Science, (February, 1966), 21-32.

42. King, Alexander. "Science and Technology in the New Europe," Daedalus, XCIII (Winter, 1964), 434-458.

43. ________. "Toward a National Science Policy," Impact of Science on Society, XII (Number 3, 1962), 157-175.

44. Knoppers, Antonie T. "The 'Technostructure' Gap," Interplay, I (April, 1968), 26-28, 34.

45. Kowarski, L. "The Making of CERN--An Experiment in Cooperation," Bulletin of the Atomic Scientists, XI (December, 1955), 354-357, 381.

46. Langer, Elinor. "Science and Government: OECD Ministers for Science Compare Experiences on National Policies," Science, CXLII (October 18, 1963), 372.

47. Levitt, T. "The Gap Is Not Technological," The Public Interest, Number 12 (Summer, 1968), 119-124.

48. Lockspeiser, Ben. "Twelve Countries Combine in Nuclear Research," New Scientist, Number 12 (February 7, 1957), 9-11.

49. Lubell, Harold. "Security of Supply and Energy Policy in Western Europe," World Politics, XIII (April, 1961), 400-422.

50. Lust, R. "The European Space Research Organization," Science, CXLIX (July 23, 1965), 394-397.

51. McElheny, Victor K. "The Cooperative Space Research Agency," Science, CXLIV (April 17, 1964), 275-277.

52. ________. "European Launcher Development Organization: Its Changing Role," Science, CXLVIII (June 25, 1965), 1705-1706.

53. ________. "Particle Accelerators at CERN," Science, CXLIV (May 22, 1965), 983-986.

54. ________. "Technologically, the Atlantic Community Exists," Science, CXLIX (September 3, 1965), 1080-1082.

55. ________. "Time of Trial for European Research Cooperation," Science, CXLVII (January 15, 1965), 280-282.

56. Miller, G. P. "A Parliamentarian's View of Science and Technology," Congressional Record, CXIV (May 16, 1968), H4303-H4306.

57. Moller, Werner. "National Research Councils and Science Policy," Impact of Science on Society, VI (September, 1955), 123-130.

58. Moor, E. J. "A Technology Gap?" Lex et Scientia, VI (October-December, 1969), 146-155.

59. Multhauf, Robert P. "European Science Museums," Science, CXXVIII (September 5, 1958), 512-519.

60. Nature. "Dainton's Thoughts," Nature, CCXXV (February 21, 1970), 679-680.

61. ________. "ESTRO and ELDO: Point of No Return," Nature, CCXXXI (May 28, 1971), 227-228.

62. ________. "Loose Edges in the Grand Design," Nature, CCXXV (February 21, 1970), 673-674.

63. ________. "New European Organization," Nature, CCXXV (February 21, 1970), 677-678.

64. ________. "Nuclear Energy in Europe," Nature, CCXXXII (July 23, 1971), 211-212.

65. ________. "One More Bridge," Nature, CCXXXIII (October 22, 1971), 512-513.

66. ________. "Science in Europe," Nature, CCXXII (May 31, 1969), 823-848.

67. ________. "Survey of Science in Europe," Nature, CCXXVI (June 13, 1970), 1009-1024.

68. ________. "Survey of Science in Europe," Nature, CCXXXI (May 28, 1971), 221-236.

69. ________. "Tale of Two Countries," Nature, CCXV (July 1, 1967), 9-10.

70. New Scientist. "NATO into the Attack," New Scientist, XLIV (November 20, 1969), 387-388.

71. NATO Letter. "Committee on the Challenges of Modern Society and NATO's Third Dimension," NATO Letter, XVIII (February, 1970), 1-13.

72. ________. "Committee on the Challenges of Modern Society," NATO Letter, XVIII (January, 1970), 8-12.

73. OECD Observer. "The European Nuclear Energy Agency: Reports on Its Activities," OECD Observer, Number 20 (February, 1966), 37-41.

74. ________. "Progress in Science Policy," OECD Observer, Number 30, (October, 1967), 12-15.

75. ________. "The Technological Gap in the Electronics Industry and Its Causes," OECD Observer, Number 37 (December, 1968), 40-44.

76. ________. "Technological Gaps in the Computer Industry," OECD Observer, Number 40 (June, 1969), 31-37.

77. ________. "Technological Gaps in the Pharmaceutical Industry," OECD Observer, Number 43 (December, 1969), 42-45.

78. ________. "Technological Gaps: Their Nature, Causes, and Effects," OECD Observer, Number 33 (April, 1968), 18-28.

79. Piganoil, Pierre. "Scientific Policy and the European Community," Minerva, VI (Spring, 1968), 354-365.

80. Polach, J. G. "Nuclear Power in Europe at the Crossroads," Bulletin of the Atomic Scientists, XXV (October, 1969), 15-18; 20.

81. Redeker, J. A. "European Worry over Nuclear Monopoly," New Scientist, XXXVII (February 15, 1968), 356-357.

82. Reed, L. "Pooling Europe's Sea Resources," New Scientist, XXXIX (August 1, 1968), 231-232.

83. Richardson, Jacques and Ford Park. "Why Europe Lags Behind," International Science and Technology, Number 77 (May, 1968), 20-29.

84. Rose, Hilary and Steven Rose. "Knowledge and Power," New Scientist, XLII (April 17, 1969), 108-109.

85. Salomon, J. "Feasibility of Multilateral Cooperation," Nature, CCXVIII (June 1, 1968), 819-821.

86. ________. "Some Examples of National Science Policy," Science Policy Information, Number 5 (November, 1968), 97-110.

87. Sandgreber, J. "Nuclear Industry: Change to Build a 'New EURATOM'," New Scientist and Science Journal, LI (July, 22, 1971), 189-192.

88. Science Journal. "The Falling Growth of Science" (Interview with Anthony Crossland, British Secretary of State for Education and Science), Science Journal, III (February, 1967), 81-84.

89. Science Policy News. "Coordination of Science Policy," Science Policy News, II (November, 1970), 31-33.

90. ________. "Education and Science Priorities," Science Policy News, I (March, 1970), 101-102.

91. Scientific American. "The Greening of Technology," Scientific American, CCXXV (August, 1971), 44-45.

92. Scientific Research. "CERN: Dampened Optimism--But No Defeatism," Scientific Research, III (August 19, 1968), 33-36.

93. ________. "IDA and the Universities: What Next?" Scientific Research, III (January 8, 1968), 23-27.

94. Scientific World. "WFSW Conference on European Scientific Cooperation," Scientific World, XII (Numbers 4-5, 1968), 3-51.

95. Sims, G. and W. Bright. "A New Alliance in Science," New Scientist and Science Journal, L (June 3, 1971), 579-582.

96. Spaey, J. "Conditions for Success in the Econo[illegible]nd Social Development of Nations through Science," OECD Observer, Number 33 (April, 1968), 32-34.

97. Star, J. "European Physicist Rush in Where Politicians Fear to Tread," Scientific Research, IV (June 9, 1969), 38-41.

98. Stubbs, P. "Whither ESRO?" New Scientist, XLIV (November 13, 1969), 336-338.

99. Suranyi-Unger, T., Jr. "What Is the Technology Gap?" Interplay, II (June-July, 1968), 22-25.

100. Teich, H. "International Laboratories and European Integration," Technology Review, LXXII (December, 1969), 43; 45-47.

101. Thompson, H. "European Exchange to Promote Science," New Scientist and Science Journal, XLIX (February 18, 1971), 354-356.

102. Valery, N. "300 GeV Machine: Object Lesson in Scientific Autism," Science Journal, VII (January, 1971), 3-4.

103. Vernon, Raymond. "An Outsider's View of the Technological Gaps Report," OECD Observer, Number 33 (April, 1968), 28-31.

104. Vichney, N. "What Future for Advanced Reactors in Europe?" New Scientist, XLVIII (December 10, 1970), 434-435.

105. Walsh, John. "EURATOM: A Cut for Cooperation," Science, CLVIII (December 29, 1967), 1657.

106. __________. "NATO: A North Atlantic Technology Organization?" Science, CLV (February 24, 1967), 985-986; 988.

107. Wedgewood Benn, Anthony. "Science, Europe, and a New World," New Scientist and Science Journal, XLIX (February 18, 1971), 348-350.

108. Weisskopf, Victor. "CERN and the Proposed European Biology Laboratory," Nature, CCXVII (January 27, 1968), 317-318.

General References: Books

109. Atlantic Institute. The Technology Gap: U.S. and Europe. New York: Praeger, 1970, 158.

110. Ben-David, Joseph. Fundamental Research and the Universities: Some Comments on International Differences. Paris: Organization for Economic Cooperation and Development, 1968, 111.

111. Blackall, T. E. Concorde: The Story, the Facts, and the Figures. Henley-on-the-Thames, England: Foulis, 1969, 108.

112. Crowther, James G. Science in Liberated Europe. London: Pilot Press, 1949, 336.

113. ________. Science in Modern Society. New York: Schocken, 1968, 403.

114. ________. The Social Relations of Science. Revised Edition. London: Cresset Press, 1967, 474.

115. Freeman, D., R. Poitnant, and I. Svennilson. Science, Economic Growth, and Government Policy. Paris: Organization for Economic Cooperation and Development, 1963, 66. Excerpted in Minerva, II (Winter, 1964), 232-242.

116. Haberer, Joseph. Politics and the Community of Science. New York: Van Nostrand Reinhold, 1969, 337.

117. Landes, David S. The Unbound Prometheus: Technological Change and Industrial Development in Western Europe from 1750 to the Present. Cambridge, England: Cambridge University Press, 1969, 566.

118. Layton, Christopher. European Advanced Technology: A Program for Integration. London: Allen and Unwin, 1969, 293.

119. McCrensky, Edward. Scientific Manpower in Europe. New York: Pergamon Press, 1958, 188.

120. Mesthene, Emmanuel G. Ministers Talk about Science. Paris: Organization for Economic Cooperation and Development, 1965, 178.

121. Moonman, Eric, ed. Science and Technology in Europe. Harmondsworth, England: Penguin, 1968, 175.

122. Nelson, R. R. "Big Technology, the Technology Gap, and a Dangerous Policy Pitfall," Paper presented at the Sixth Goddard Memorial Symposium held in Washington, D.C., March 4-5, 1968. Santa Monica, California: RAND Corporation, 1968, 18. (AD 666 418)

123. Organization for Economic Cooperation and Development. Country Reports on the Organization of Scientific Research. Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Turkey, United Kingdom, and United States. Paris: OECD, May, 1966, 894. (Second printing, available as 18 booklets.)

124. ________ Development of Higher Education 1950-1967. Statistical Survey. Paris: OECD, 1970, 860.

125. ________. Energy Policy: Problems and Objectives. Paris: OECD, 1966, 187.

126. ________. Gaps in Technology. Analytical Report. Comparisons between Member Countries in Education, Research and Development, Technological Innovation, International Economic Exchanges. Paris: OECD, 1970, 300.

127. ________. Problems of Science Policy. Paris: OECD, 1968, 195.

128. ________. The Research and Development Effort in Western Europe, North America, and the Soviet Union: An Experimental International Comparison of Research Expenditures and Manpower in 1962. By C. Freeman and A. Young. Paris: OECD, 1966, 152.

129. Polach, Jarovslav G. EURATOM: Its Background, Issues, and Economic Implications. Dobbs Ferry, New York: Oceana, 1964, xxiv, 232.

130. Rose, Hilary and Steven Rose. Science and Society. London: Penguin Press, 1969, 294.

131. Schrader, Rudolf. Science and Policy: On the Interaction of Scientific and Political Affairs. New York: Macmillan, 1963, 81.

132. Servan-Schreiber, Jean-Jacques. The American Challenge. New York: Atheneum, 1968, 291.

133. Turkevich, John and Ludmilla B. Turkevich. Prominent Scientists of Continental Europe. New York: American Elsevier, 1968, 204.

134. United Nations Educational, Scientific, and Cultural Organization. National Science Policies in Europe. Paris: UNESCO, 1970, 489.

135. United Nations Educational, Scientific, and Cultural Organization. Science Policy and the European States. Paris: UNESCO, 1971, 208.

136. ________. World Directory of National Science Policy-Making Bodies. Volume I, Europe and North America. London: UNESCO, 1966, 356.

137. Walsh, Warren B. Science and International Public Affairs: Six Recent Experiments in International Scientific Cooperation. Syracuse, New York: International Relations Program, Maxwell School of Syracuse University, 1967, 161.

United Kingdom: Articles

138. Aitken, Robert. "The Constriction of University Science," New Scientist, XVIII (April 4, 1963), 16-17.

139. Albu, Auten. "The Member of Parliament, the Executive, and Scientific Policy," Minerva, II (Autumn, 1963), 1-20.

140. Anderson, John. "Science and Reconstruction," Nature, CLVI (December 22, 1945), 733-736.

141. Andrade, E. N. da C. "The Royal Society Today," New Scientist, VII (July 14, 1960), 111-113.

142. Appleton, Edward V. "Science, Government, and Industry in Britain," Bulletin of the Atomic Scientists, II (December 1, 1946), 2-5.

143. Bernal, J. D. "Public Policy and Science," Political Quarterly, XXXVIII (January-March, 1967), 10-26.

144. Berry, M. "Manpower for and from Schools," New Scientist and Science Journal, L (May 20, 1971), 444-446.

145. Blackett, P. M. S. "Memorandum to the Select Committee on Science and Technology," Nature, CCXIX (September 14, 1968), 1107-1110.

146. Blount, B. K. "The Organization and Finance of Research in the United Kingdom," Research Management, V (March, 1962), 107-120.

147. Blume, Stuart. "Research Support in British Universities," Minerva, VII (Summer, 1969), 649-667.

148. Boyle, Edward. "Technical Education in Britain," Nature, CXCVIII (April 27, 1963), 334-336.

149. Brundrett, Frederick. "The Shortage of Recruits for the Scientific Civil Service," New Scientist, VIII (September 29, 1960), 842-844.

150. Calder, Nigel. "The B.A. and the Interpretation of Science," New Scientist, VIII (September 1, 1960), 562-563.

151. ______. "Parliament and Science," New Scientist, XXII (May 28, 1964), 533-535.

152. Caplan, B. "Knowhow: An Adverse Balance for Britain," New Scientist and Science Journal, L (May 6, 1971), 326-327.

153. Carter, C. F. and B. R. Williams. "Government Scientific Policy and the Growth of the British Economy," Minerva, III (Autumn, 1964), 114-125.

154. Carter, R. "Big Technology and the Late Lamented Mintech," New Scientist and Science Journal, L (April 22, 1971), 196-198.

155. Chinneck, A. "The National Physical Laboratory," Nature, CCIII (August 8, 1964), 579-582.

156. Clarke, R. "Sponsored Research & Universities," Science Journal, V (January, 1969), 81-86.

157. Clarke, Richard. "Organization of Ministry of Technology," Nature, CCXVI (November 25, 1967), 745-746.

158. Clarke, Robin. "How the 300 GeV Decision Was Made," Science Journal, V (March, 1969), 4-5; 7.

159. Cockcroft, John. "Retrospect," Nature, CCXV (September 16, 1967), 1228-1229.

160. Cotgrove, Stephen F. "Weaknesses of Part-Time Technical Education," New Scientist, IV (November 20, 1958), 1308-1310.

161. Cottrell, A. H. "Science and Economic Growth in the United Kingdom," Advancement of Science, XXIII (November, 1966), 333-342.

162. Croome, A., M. Sherwood, and N. Valery. "Whitehall's Call for Relevant Science," New Scientist and Science Journal, L (June 17, 1971), 672-673.

163. Curran, S. C. "The Technological University," Nature, CXC (April 8, 1961), 128-129.

164. D'aeth, R. "Proposal for an Educational Research Council," Nature, CC (October 12, 1963), 116-118.

165. Dale, Henry. "The Medical Research Council: A Memoir of Its Beginnings," New Scientist, VIII (April 21, 1960), 998-1000.

166. Davies, D. S. and M. C. McCarthy. "Education for Change," Nature, CCXIV (June 10, 1967), 1079-1081.

167. Douglass, William. "Cosseting the Ph.D's," New Scientist, XXXVII (January 18, 1968), 132-134.

168. ________. "How to Stop the Brain Drain," New Scientist, XXIV (April 6, 1967), 39-41.

169. Edwards, E. G. "Colleges of Advanced Technology in Britain," Nature, CXCIX (September 21, 1963), 1131-1136.

170. Ellis, R. Hobart Jr. "Britons Seek Closer Relations between Industry and University," Physics Today, XXI (January, 1968), 54-58.

171. Fishlock, David. "Blueprint for British Technology?", New Scientist, XXXII (December 1, 1966), 515-517.

172. Florey, Howard. "The Future of the Royal Society," New Scientist, XXIV (December 3, 1964), 638-640.

173. ________. "The Royal Society: Anniversary Address," Nature, CCVIII (December 18, 1965), 1141-1145.

174. Flowers, B. H. "Science, Industry, and Government," Nature, CCXXII (May 3, 1969), 421-425.

175. Foote, George A. "Mechanism, Materialism, and Science in England, 1800-1850," Annals of Science, VIII (June 28, 1952), 152-161.

176. Ford, B. J. "Telling the People," New Scientist, XXXVII (January 11, 1968), 89-90.

177. Goodeve, Charles. "A 'Route 128' for Britain?" New Scientist, XXXIII (February 9, 1967), 346-348.

178. Gray, J. A. B. "Role of the Research Councils," Nature, CCXXX, (March 5, 1971), 23-25.

179. Greenberg, Daniel S. "Academic Finance: British System Smoothly Functions in 50th Year," Science, CLXIX (August 14, 1970), 658-660.

180. ________. "Brain Drain: The View from This Side of the Atlantic," Science, CXLIII (February 21, 1964), 786.

181. ________. "Open University: Britain's New Venture in Higher Education," Science, CLXV (August 29, 1969), 881-882.

182. ________. "Research in Britain: A Non-Weeping Formula for Living on Tight Funds," Science, CLXVII (March 20, 1970), 1596-1598.

183. Grieg, James. "Technological Manpower and Postgraduate Study," Nature, CCX (April 30, 1966), 457-459.

184. Gunn, Lewis A. "Organizing for Science in Britain: Some Relevant Questions," Minerva, V (Winter, 1967), 167-197.

185. Gunston, B. "'Harsh Decision' for U. K. Science," Science Journal, Va (September, 1969), 9; 11.

186. Haigh, G. E., A. W. Pearson, D. S. Watkins, and M. Gibbons. "NRDC and the Environment for Innovation," Nature, CCXXXII (August 20, 1971), 527-531.

187. Hamilton, D. "What Next for the RAs?" New Scientist and Science Journal, XLIX (January 28, 1971), 192-193.

188. Hartley, Harold. "The Tercentenary of the Royal Society," American Scientist, XLVIII (September, 1960), 279-299.

189. Hatch, Stephen. "Why Scientists Leave Britain," New Scientist, XXXIV (April 3, 1967), 98-100.

190. Hatch, Stephen and Ernest Rudd. "Emigrants and Homecomers," New Scientist, XXVIII (November 18, 1965), 527-528.

191. Hawkes, Nigel. "Britain: Successor to 'Mintech' Loses Jurisdiction over Research," Science, CLXXIII (July 2, 1971), 34-36.

192. ________. "Recipe for Nuclear Power," Nature, CCXVI (December 2, 1967), 854-855.

193. Hill, R. B. "The Improvement of Returns from Research and Development Investment," Advancement of Science, XXV (March, 1969), 269-278.

194. Hindle, Edward. "The Ass that Plodded from Ridicule to Renown," New Scientist, II (September 5, 1957), 15-18.

195. ________. "The Royal Society," Impact of Science on Society, X (Number 3, 1960), 157-165.

196. Hinton, Christopher. "Atomic Energy Developments in Great Britain," Bulletin of the Atomic Scientists, IX (December, 1953), 366-368; 390.

197. Hiscocks, E. S. "Organization of Science in the United Kingdom," Science, CXXIX (March, 1959), 689-693.

198. Hogg, Quintin M. (Lord Hailsham). "The First Minister for Science," Nature, CLXXXIV (October 24, 1959), 1263-1264.

199. ________. "Science and Government in a Free Society," Nature, CXCII (November 4, 1961), 393-398.

200. Hoyle, Fred. "The Case against a British Space Programme," New Scientist, VII (August 11, 1960), 394-395.

201. Hutchinson, Eric. "A Fruitful Cooperation between Government and Academic Science: Food Research in the United Kingdom," Minerva, X (January, 1972), 19-50.

202. ________. "Scientists and Civil Servants: The Struggle over the National Physical Laboratory in 1918," Minerva, VII (Spring, 1969), 373-398.

203. Hutchinson, Eric. "Scientists as an Inferior Class: The Early Years of the DSIR," Minerva, VIII (July, 1970), 396-411.

204. Jewkes, John. "How Much Science?" Advancement of Science, XVI (September, 1959), 67-80.

205. Johnstone, R. Edgeworth. "From Practice to Theory and Back," Nature, CCXIII (March 25, 1967), 1177-1179.

206. Jones, Harold S. "The Royal Observatory, Greenwich," Endeavor, VII (January, 1948), 9-14.

207. Jones, R. V. "Science and the State," Advancement of Science, XX (January, 1964), 393-405.

208. Linstead, Hugh. "Scientist and Politician as Partners: The British Parliamentary and Scientific Committee," Science, CVIII (July 16, 1948), 47-50.

209. Lovell, A. C. B. "The Case for an Independent British Space Programme," New Scientist, VII (June 30, 1960), 1644-1646.

210. Low, Ian. "The Nation's Experiments in Science Policy," New Scientist, XXIX (January 20, 1966), 164-165.

211. McCarthy, C. "Universities and the Future," New Scientist and Science Journal, L (May 20, 1971), 440-442.

212. Macfarlane, W. A. "The Organization of Government Science in the United Kingdom," Scientific Monthly, LXXI (August, 1950), 85-90.

213. Macleod, Roy M. "The Support of Victorian Science: The Endowment of Research Movement in Great Britain, 1868-1900," Minerva, IX (April, 1971), 197-230.

214. Macleod, Roy M. and E. K. Andrews. "The Committee of Civil Research: Scientific Advice for Economic Development, 1925-1930," Minerva, VII (Summer, 1969), 680-705.

215. Maddox, John. "Science Policy Shapes Up as Issue in Coming British Election," Science, CXLIII (March 13, 1964), 1146.

216. Martin, D. C. "The Tercentenary of the Royal Society," Science, CXXXI (June 17, 1960), 1785-1790.

217. Massey, Harrie. "Evolution of a Policy for Science," New Scientist, XXXII (November 24, 1966), 428-429.

218. Mencher, A. G. "Making Technology Pay: A British Dilemma," Technology Review, LXXII (October-November, 1969), 12-13.

219. ________. "Management by Government: Science and Technology in Britain," Bulletin of the Atomic Scientists, XXIV (May, 1968), 22-27.

220. Merton, Robert K. "Science, Technology, and Society in Seventeenth Century England," Osiris, IV (1938), 360-362.

221. Moore, A. F. "British Space Research: The Programme and Its Aims," New Scientist, XIV (April 12, 1962), 17-20.

222. Murray, Keith. "Technology in the Universities," Nature, CXCVI (November 24, 1962), 710-714.

223. Murray, L. "Trade Unions and Technical Change," Advancement of Science, XXV (March, 1969), 326-334.

224. Nature. "The Short History of the Ministry of Technology," Nature, CCXI (July 9, 1966), 115.

225. ________. "Two Views of British Science," Nature, CCXXXIV (November 26, 1971), 169-171.

226. New Scientist. "The Brain Drain--Two Points of View," New Scientist, XXXII (December 1, 1966), 502-503.

227. ________. "BRDC Proposal," New Scientist, XLV (January 22, 1970), 139.

228. ________. "Green Paper Reviewed," New Scientist, XLV (March 12, 1970), 498-502.

229. ________. "Science, Technology, and the Election," New Scientist, XXIX (March 24, 1966), 760-762.

230. New Scientist. "Summary of the Robbins Report," New Scientist, XX (October 24, 1963), 196-197.

231. OECD Observer. "Energy in the United Kingdom: Four Sources Instead of Two," OECD Observer, Number 37 (December, 1968), 36-39.

232. ________. "Regional Development Policies in the United Kingdom," OECD Observer, Number 28 (June, 1967), 6-9.

233. Oriel, John. "Too Many Learned Societies?" New Scientist, VII (April 7, 1960), 854-856.

234. Peierls, Rudolf E. "Britain in the Atomic Age," Bulletin of the Atomic Scientists, XXVI (June, 1970), 40-46.

235. Philip, Duke of Edinburgh. "The British Association for the Advancement of Science," Advancement of Science, XV (March, 1959), 309-314.

236. ________. "What Next?" New Scientist, XXXII (November 24, 1966), 419-420.

237. Pippard, A. B. "Science as a Constituent of University Education," Nature, CCXIX (September 28, 1968), 1307-1308.

238. Price, M. Philips. "The Parliamentary and Scientific Committee of Great Britain," Impact of Science on Society, III (Winter, 1952), 258-276.

239. Raison, Timothy. "Research in the C.A.T.'s," New Scientist, XI (July 6, 1961), 18-19.

240. ________. "Too Many Scientists--or Too Few?" New Scientist, VI (December 17, 1959), 1258-1260.

241. Robinson, Robert. "Science and the New Politics," New Scientist, XX (October 10, 1963), 74-75.

242. Rudd, E. "The Rate of Economic Growth, Technology, and the Ph. D.," Minerva, VI (Spring, 1968), 366-387.

243. Science Policy News. "R & D in the British Business Enterprise Sector," Science Policy News, I (January, 1970), 77-81.

244. Scientific Research. "U.K. Research Funds Crisis Mirrors U.S.," Scientific Research, I (January, 1967), 21-22.

245. Sherman, B. "Why Is There a Science Job Crisis?" New Scientist and Science Journal, LI (August 19, 1971), 415-416.

246. Sherwood, M. "Government Pay Goads the Scientists," New Scientist and Science Journal, LI (August 5, 1971), 3[illegible]308.

247. ________. "Science and the Politician," New Scientist and Science Journal, L (May 13, 1971), 402-403.

248. Smith, A. "How Is Science Policy Made in Britain?" Science Forum, IV (August, 1971), 14-15.

249. Smith, R. A. "The University and the Research Institute," Nature, CCII (May 9, 1964), 529-530.

250. Spence, R. "Twenty-One Years at Harwell," Nature, CCXIV (April 22, 1967), 343-344; 436-438.

251. Stubbs, Peter. "State Funds and Scientific Freedom," New Scientist, XVIII (September 24, 1964), 755-757.

252. Sutherland, Gordon. "The Brain Drain," Political Quarterly, XXXVIII (January-March, 1967), 51-61.

253. ________. "Government and Science in Britain and the U.S.," Bulletin of the Atomic Scientists, XXIV (April, 1968), 20-28.

254. ________. "The Migration of Scientists," Advancement of Science, XXV (September, 1968), 84-91.

255. Swann, Michael. "The Medical Research Council after 50 Years," New Scientist, XX (November 21, 1963), 455-457.

256. Tinker, J. "Environmental Politician," New Scientist and Science Journal, L (April 22, 1971), 214-216.

257. Tobias, S. A. "Engineering and Education," Science Journal, I (November, 1965), 80-85.

258. Todd, Alexander R. "Scientific Policy in Britain," Science, CXLIX (July 9, 1965), 156-162.

259. Valery, N. "Austerity Ahead for University Research," New Scientist, XLIX (January 14, 1971), 61-62.

260. ________. "Contract Research Comes In from the Cold," New Scientist and Science Journal, L (April 22, 1971), 198-199.

261. Varcoe, Ian. "Scientist, Government, and Organized Research in Great Britain, 1914-1916: The Early History of the DSIR," Minerva, VIII (April, 1970), 192-216.

262. Walsh, John. "Britain and the EEC: How Strong Is the Technological Argument?" Science, CLXXIV (October 29, 1971), 476-479.

263. ________. "British Science Policy: A Crisis of Confidence," Science, CLXXIV (November 5, 1971), 572-574.

264. ________. "The Open University: Breakthrough for Britain?" Science, CLXXIV (November 12, 1971), 675-678.

265. ________. "Social Science: British Council Has Key Role in Research Support," Science, CLX (April 26, 1968), 402-404.

266. Waters, D. W. "The Restoration of the Royal Observatory, Greenwich," Endeavour, XXVI (September, 1967), 122-125.

267. Watson, Christopher, J.H. "Myopia among the Power Men," New Scientist, XXXVI (November 23, 1967), 476-477.

268. Werksey, Paul G. "British Scientists and 'Outsider' Politics 1931-1945," Science Studies, I (January, 1971), 67-83.

269. ________. "The Perennial Dilemma of Science Policy," Nature, CCXXXIII (October 22, 1971), 529-532.

270. Wilson, Harold. "Science, Industry, and Government," Nature, CCVI (April 17, 1965), 230-232.

271. Wilson, James A. "The Emigration of British Scientists," Minerva, V (Autumn, 1966), 20-29.

272. Woolf, Leonard. "Britain in the Atomic Age," Political Quarterly, XVII (January-March, 1946), 12-24.

United Kingdom: Books

273. Andrade, E. N. da C. A Brief History of the Royal Society. London: Royal Society, 1960, 28.

274. Appleton, Edward V. Science and the Nation. Edinburgh: Edinburgh University Press, 1957, 104.

275. Babbage, Charles. The Exposition of 1851; Or, Views of the Industry, the Science, and the Government of England. London: Cass, 1968, 289.

276. Bray, Jeremy. Decision in Government. London: Gollancz, 1970, 320.

277. Britain: An Official Handbook. London: Central Office of Information, 1967, ix, 558.

278. Burgess, Tyrell and John Pratt. Technical Education in the United Kingdom. Paris: Organization for Economic Cooperation and Development, 1971, [illegible]

279. Cardwell, D. S. L. The Organization of Science in England: A Retrospect. London: William Hanemann, 1957, ix, 204.

280. Clark, Ronald W. The Birth of the Bomb: The Untold Story of Britain's Part in the Weapon That Changed the World. New York: Horizon Press, 1961, 209.

281. ________. Tizard. Cambridge, Massachusetts: M.I.T. Press, 1965, 458.

282. Cockcroft, John, ed. The Organization of Research Establishments. New York: Cambridge University Press, 1965, 281.

283. Cope, Zachary. The Royal College of Surgeons of England: A History. Springfield, Illinois: Charles C. Thomas, 1959, xii, 360.

284. Crowther, James G. Statesmen of Science. Chester Springs, Pennsylvania: Defour, 1966, 391.

285. Gowing, Margaret M. Britain and Atomic Energy, 1939-1945. London: Macmillan, 1964, 464.

286. Habakkuk, Krother J. American and British Technology in the Nineteenth Century: The Search for Labour-Saving Inventions. Cambridge, England: Cambridge University Press, 1962, 222.

287. Halsey, A.H. and M.A. Trow, with the assistance of Oliver Fulton. The British Academies. London: Faber, 1971, 560.

288. Harrod, Roy F. The Prof: A Personal Memoir of Lord Cherwell. London: Macmillan, 1959, 281.

289. Hartley, Harold. The Royal Society, Its Origins and Founders. London: Invicta Press, 1960, 275.

290. Himsworth, H. The Development and Organisation of Scientific Knowledge. London: Heinemann, 1970, 175.

291. Hogg, Quintin M. (Lord Hailsham). Science and Government. The Eighth Fawley Foundation Lecture. Southhampton, England: University of Southhampton, 1961, 20.

292. ________. Science and Politics. London: Faber and Faber, 1963, 110.

293. Lovell, Bernard. The Story of Jodrell Bank. New York: Harper and Row, 1968, 265.

294. Macreavy, S. E., ed. Guide to Science and Technology in the United Kingdom. Guernsey, British Channel Islands: Hodgson, 1971, 450.

295. Melville, Harry. The Department of Scientific and Industrial Research. London: Allen and Unwin, 1962, 200.

296. Merton, Robert K. Science, Technology, and Society in Seventeenth Century England. New York: Fertig, 1970, 279.

297. Organization for Economic Cooperation and Development. Revisions of National Science Policy: United Kingdom and Germany. Paris: OECD, 1967, 259.

298. Prandy, Kenneth. Professional Employees: A Study of Scientists and Engineers. London: Faber and Faber, 1965, 197.

299. Royal Society. The Emigration of Scientists from the United Kingdom. London: Royal Society of London, 1963, 32.

300. Snow, Charles P. A Postscript to Science and Government. Cambridge, Massachusetts: Harvard University Press, 1962, 37.

301. ________. Science and Government. Godkin Lectures. Cambridge, Massachusetts: Harvard University Press, 1961, vi, 88.

302. Stimson, Dorothy. Scientists and Amateurs: A History of the Royal Society. New York: Henry Schuman, 1948, xiii, 270.

303. Sussman, Herbert L. Victorians and the Machine: The Literary Response to Technology. Cambridge, Massachusetts: Harvard University Press, 1968, 261.

304. Talbot, C. H. Medicine in Medieval England. New York: American Elsevier, 1969, 222.

305. Tavistock Institute of Human Relations. Social Research and a National Policy for Science. London: Tavistock, 1964, 44.

306. Teeling-Smith, George, ed. Science, Industry, and the State. New York: Pergamon Press, 1965, 100.

307. United Kingdom. Agricultural Research Council. Annual Report 1969-70. London: Her Majesty's Stationery Office, 1970, 104.

308. ________. Central Advisory Council for Science and Technology. Technological Innovation in Britain. London: Her Majesty's Stationery Office, 1968, 25.

309. ________. Department of Education and Science. Education and Science in 1970. London: Her Majesty's Stationery Office, 1971, 96.

310. ________. Department of Education and Science. Science Research Council. Report for the Year 1969-70. London: Her Majesty's Stationery Office, 1970, 80.

311. United Kingdom. Department of Education and Science. Scientific Research in British Universities and Colleges. 1970-1971. Volume I: Physical Sciences, 1971, 868. Volume II: Biological Sciences, 1971, 732. Volume III: Social Sciences (Including Government Departments and Other Institutions), 1971, 640. London: Her Majesty's Stationery Office, 1971.

312. ________. House of Commons. Medical Research Council Annual Report. April 1970-March 1971. London: Her Majesty's Stationery Office, 1971, 136.

313. ________. Ministry of Technology. National Research Development Corporation. 21st Annual Report. London: Her Majesty's Stationery Office, 1970, 84.

314. ________. Ministry of Technology. The Survey of Professional Engineers 1968. London: Her Majesty's Stationery Office, 1968, 68.

315. ________. Ministry of Technology. The Survey of Professional Scientists 1968. London: Her Majesty's Stationery Office, 1968, 48.

316. ________. Ministry of Technology, and the Department of Education and Science. Statistics of Science and Technology 1970. London: Her Majesty's Stationery Office, 1970, 136.

317. ________. Natural Environment Research Council. Report of the Council for the Period April 1, 1969-March 31, 1970. London: Her Majesty's Stationery Office, 1970, 116.

318. Walker, R. Milnes. Medical Education in Britain. London: Nuffield Provincial Hospitals Trust, 1965, 101.

319. Vig, Norman J. Science and Technology in British Politics. New York: Pergamon Press, 1968, 190.

320. Zuckerman, Solly. Beyond the Ivory Tower: The Frontiers of Public and Private Science. New York: Taplinger, 1971, 243.

321. ________. Scientists and War: The Impact of Science on Military and Civil Affairs. London: Hamish Hamilton, 1966, 177.

France: Articles and Books

322. Auger, Pierre. "Space Research for Smaller Countries--I: The French Programme," New Scientist, XVI (December 20, 1962), 674-676.

323. Ben-David, Joseph. "The Rise and Decline of France as a Scientific Centre," Minerva, VIII (April, 1970), 160-179.

324. Bugge, Thomas. Science in France in the Revolutionary Era. Ed. by Maurice P. Crosland. Cambridge, Massachusetts: M.I.T. Press, 1970, 239.

325. Chodkiewicz, M. "French Science Goes through a 'Pause'," Science Journal, V (December, 1969), 11; 13.

326. Combrisson, Jean. "Physics in France," Physics Today, XX (November, 1967), 55-61.

327. The Delegate General and the Consultative Committee on Scientific and Technological Research of France. "Scientific and Technological Research: Fourth Plan 1962-1965," Minerva, I (Summer, 1963), 470-492.

328. Finch, D. I. "How France Is Speeding Up Technical Education," New Scientist, V (April 9, 1959), 805-807.

329. Gibello, Henri. "Research and Development Activities in France," Research Management, V (November, 1962), 475-483.

330. Gilpin, Robert. France in the Age of the Scientific State. Princeton, New Jersey: Princeton University Press, 1968, 474.

331. Goldschmidt, Bertrand. "The French Atomic Energy Program," Bulletin of the Atomic Scientists, XVII (October, 1962), 39-42; "Part II," Ibid. XVII (September, 1962), 46-48.

332. Greenberg, Daniel S. "France: Profit Rather than Prestige Is New Policy for Research," Science, CLXV (September 26, 1969), 1334-1337.

333. Grignon, C. and J. C. Passeron. Case Studies on Innovation in Higher Education. French Experience before 1968. Paris: Organization for Economic Cooperation and Development, 1970, 140.

334. Hahn, Roger. The Anatomy of a Scientific Institution: The Paris Academy of Sciences, 1663-1803. Berkeley: University of California Press, 1971, 433.

335. Impact of Science on Society. "Science and Society: French Bibliography, 1900-1950," Impact of Science on Society, II (July-December, 1951), 65, 112.

336. Kelly, George A. "The Political Background of the French A-Bomb," Orbis, IV (Fall, 1960), 284-306.

337. King, James E. Science and Rationalism in the Government of Louis XIV, 1661-1683. Baltimore: Johns Hopkins Press, 1949, 337. (Johns Hopkins Studies in Historical and Political Science, Series LXVI, Number 2)

338. Kowarsky, L. "Atomic Energy Developments in France," Bulletin of the Atomic Scientists, IV (May, 1948), 139-140; 154-155.

339. ________. "Atomic Research in France," Bulletin of the Atomic Scientists, II (October 1, 1946), 7-8; 25.

340. Low, Ian. "French Plan for Science," New Scientist, XXX (May 19, 1966), 463.

341. McKie, Douglas. "The Early Years of the Académie des Sciences," Endeavour, XXV (May, 1966), 100-103.

342. Morel, Pierre. Engineering Schools in France. New York: Cultural Center of the French Embassy, 1959, 84. (French Bibliographical Digest, Series 11, Number 28)

343. Nature. "France: At The Crossroads," Nature, CCXXXI (May 28, 1971), 229-230.

344. New Scientist. "DeGaulle's Techno-Diplomacy," New Scientist, XXXI (July 7, 1966), 10-12.

345. OECD Observer. "French Science Policy," OECD Observer, Number 23 (August, 1966), 10-14.

346. Organization for Economic Cooperation and Development. Review of National Science Policy--France. Paris: OECD, 1966, 133.

347. Perrin, Francois. "Atomic Energy in France," Bulletin of the Atomic Scientists, IX (March, 1955), 92-93.

348. Quinn, James B. "National Planning of Science and Technology in France," Science, CL (November 19, 1965), 993-1003.

349. Renou, Jean M. "Atomic Energy in France," New Scientist, IV (October 9, 19[illegible]), 1011-1014.

350. Scheinman, Lawrence. Atomic Energy Policy In France under the Fourth Republic. Princeton, New Jersey: Princeton University Press, 1965, 259.

351. Science Policy News. "France: Trend of R & D Expenditure 1963-1975," Science Policy News, III (September, 1971), 25.

352. Trehin, Robert "Links with Industry at the University of Grenoble," Impact of Science on Society, XV (Number 1, 1965), 27-39.

353. Walsh, John. "France: First the Bomb, Then the 'Plan Calcul'," Science, CLVI (May 12, 1967), 767-770.

354. Williams, L. Pearce. "Science, Education, and the French Revolution," Isis, XLIV (December, 1953), 311-330.

355. ________. "Science, Education, and Napoleon I," Isis, XLVIII (December, 1957), 369-382.

Germany: Articles and Books

356. Audrieth, Ludwig F. and Herman I. Chinn. The Organization of Science in Germany. Washington, D.C.: National Science Foundation, 1963, 121.

357. Curtis, Roger W. "The Max Planck Institutes," International Science and Technology, Number 19 (July, 1963), 42-47.

358. Edelstein, Julius C. C. "Science as Reparations," Physics Today, I (December, 1948), 7-14.

359. Goudsmit, Samuel A. ALSOS: The Search for the German Atom Bomb. London: Sigma, 1947, 259.

360. Greenberg, Daniel S. "Germany: Booming Research Effort Turning to Space and Computers," Science, CLXIV (April 18, 1969), 281-283.

361. Hammond, B. "Universities Encroaching on the Max Plancks," Science Journal, V (February, 1969), 6-7.

362. Horne, J. "The Council for Science and Technology of Western Germany," Nature, CLXXXIII (February 21, 1959), 512-513.

363. ________. "The Technische Hochschulen of Western Germany," Nature, CLXXX (December 28, 1957), 1445-1448.

364. Irving, David. The German Atomic Bomb. New York: Simon and Schuster, 1968, 329. Reviews of this book by Eugene Rabinowitch, Werner Heisenberg, and Hans E. Seuss appear in the Bulletin of the Atomic Scientists, XXIV (June, 1968), 32-39.

365. Kenyon, Richard L. "The FIAT Review of German Science," Chemical and Engineering News, XXV (April 7, 1947), 962-963.

366. Luscher, Edgar. "Physics in West Germany," Physics Today, XIX (August, 1966), 46-54.

367. McElheny, Victor. "West Germany Debates a Cultural Crisis," Science, CXLVII (February 5, 1965), 589-591; "West German Research Spending: Plans for 1966-1968," Ibid., CXLVII (April 2, 1965), 59-60.

368. Marks, D. "West German Science Expands," Science Journal, Va (October, 1969), 11.

369. Michaelis, Anthony R. "The Restoration of Science in Germany," New Scientist, XVII (March 21, 1963), 646-649.

370. National Science Foundation. International Science Reports, No. 2: The Organization of Science in Germany. Washington, D.C.: U.S. Government Printing Office, 1963, viii, 121.

371. Nature. "Science and Technology in Western Germany," Nature, CLXXVII (February 18, 1956), 316-318.

372. OECD Observer. "Science Policy in Germany and the United Kingdom," OECD Observer, Number 24 (October, 1966), 30-34.

373. Organization for Economic Cooperation and Development. Reviews of National Science Policy: United Kingdom and Germany. Paris: OECD, 1967, 259.

374. Pfetsch, Frank. "Scientific Organization and Science Policy in Imperial Germany, 1871-1914: The Foundation of the Imperial Institute of Physics and Technology," Minerva, VIII (October, 1970), 557-580.

375. Ringer, F. K. The Decline of the German Mandarins: The German Academic Community, 1890-1933. Cambridge, Massachusetts: Harvard University Press, 1969, 528.

376. Roberg, Norman B. "Medical Reform in West Germany," Journal of the American Medical Association, CC (May 15, 1967), 603-608.

377. Science Council of West Germany. "Recommendations of the Science Council for the Development of Scientific Institutions in Western Germany, Part I: Colleges and Universities," Minerva, I (Autumn, 1962), 87-105.

378. ________. "Suggestions of the Science Council on the Pattern of New Universities in Western Germany," Minerva, I (Winter, 1963), 217-225.

379. Science Policy News. "Higher Education and Research in a Divided Germany," Science Policy News, I (January, 1970), 81-83.

380. Shoemaker, T. "Backbone of German Science," Science News, XCV (April 19, 1969), 386-387.

381. Stein, B. R. "Academic Research in Germany: A New Support Program," Science, CLXV (September 12, 1969), 1096-1100.

382. Stubbs, Peter. "Impressions of Nuclear Germany," New Scientist, XXXVI (October 26, 1967), 228-230.

383. United Nations Educational, Scientific, and Cultural Organization. Science Policy and Organization of Research in the Federal Republic of Germany. Paris: UNESCO, 1969, 95.

384. Valery, N. "Germany's Science Boom Gets Underway," New Scientist and Science Journal, L (May 20, 1971), 471-472.

385. Valery, N. "The Re-Birth of German Science," Science Journal, V (March, 1969), 82-87.

386. Walsh, J. "Max Planck Society: Filling a Gap in German Research," Science, CLX (June 14, 1968), 1209-1210.

Other Countries: Articles and Books

387. Albareda, J. M. "Organization and Trends of Scientific Research in Spain: Consjo Superior de Investigaciones Cientificas," Impact of Science on Society, XV (Number 1, 1965), 41-55.

388. Bannier, J. H. "Z.W.O., the Netherlands Science Foundation," Science, CXIII (February 23, 1951), 197-201.

389. Blount, B. K. "Consejo Superior de Investigaciones Cientificas, Spain," Nature, CCV (January 23, 1965), 340-341.

390. Greenberg, Daniel S. "Denmark: A Late but Hurrying Entry in Science Policy Planning," Science, CLXVI (October 31, 1969), 586-588.

391. ________. "Science in Italy: Reform Effort Takes a Sharp Turn Leftward," Science, CLXVII (March 27, 1970), 1704-1706.

392. Halsey, A. H. "Science and Government in Sweden: Impressions from an OECD Conference," Minerva, II (Autumn, 1963), 54-60.

393. Jamison, A. "Swedish Science: Saying What Should Be Done," Technology Review, LXXIII (April, 1971), 12-13.

394. Julius, H. W. "Scientific Policy in the Netherlands," Minerva, V (Summer, 1967), 507-519.

395. Luck, James M. Science in Switzerland. New York: Columbia University Press, 1967, 419.

396. Lundbergh, Holger. "Sweden's Atomic Energy Program," Bulletin of the Atomic Scientists, XV (May, 1959), 219-220.

397. McElheny, Victor. "Research Climate in Italy," Science, CXLV (August 14, 1964), 690-693; "Part II," Ibid., CXLVII (April 9, 1965), 205-207.

398. Major, Robert. "Organization of Scientific Activities in Norway," Science, CXXIX (March, 1959), 694-700.

399. Michelson, Borge. "National Developments Based on Science: The Case of Denmark," Impact of Science on Society, IV (Spring, 1953), 29-54.

400. Minerva. "Recommendations for a Norwegian Research Policy," Minerva, VII (Spring, 1969), 465-489.

401. ________. "Science Policy in Italy: A Policy for Scientific Research," Minerva, II (Winter, 1964), 210-224.

402. ________. "Science Policy in Italy: The Reform of the Organization of Scientific Research in Italy," Minerva, II (Winter, 1964), 225-231.

403. ________. "Scientific Research and Economic Development in Spain," Minerva, III (Spring, 1965), 385-391.

404. Nature. "Switzerland: Searching for a Science Policy," Nature, CCXXXI (May 28, 1971), 224-225.

405. OECD Observer. "Belgium's Policy for the Sciences," OECD Observer, Number 20 (February, 1966), 6-9.

406. ________. "Norwegian Science Policy," OECD Observer, L (February, 1971), 27-31.

407. ________. "Science Policy in Italy," OECD Observer, Number 42 (October, 1969), 27-31.

408. Organization for Economic Cooperation and Development. Reviews of National Science Policy: Austria. Paris: OECD, 1971, 246.

409. ________. Reviews of National Science Policy: Belgium. Paris: OECD, 1966, 125.

410. ________. Reviews of National Science Policy: Greece. Paris: OECD, 1965, 71.

411. ________. Reviews of National Science Policy: Italy. Paris: OECD, 1969, 209.

412. Organization for Economic Cooperation and Development. Reviews of National Science Policy: Norway. Paris: OECD, 1970, 194.

413. ________. Reviews of National Science Policy: Sweden. Paris: OECD, 1964, 66.

414. Randers, Gunnar. "The Dutch-Norwegian Atomic Energy Project," Bulletin of the Atomic Scientists, IX (December, 1953), 369-371.

415. ________. "Planning for Atomic Physics in Norway," Bulletin of the Atomic Scientists, VI (May, 1950), 142.

416. Scandinavian Research Information Notes. Published in English since 1966 as a semiannual bulletin by Nordforsk, Stockholm.

417. Science Policy News. "Netherlands: Structure of the Government Organization for Science and Technology," Science Policy News, XI (March, 1971), 58-62.

418. ________. "Norway: Proposals to Reorganise Research Structure," Science Policy News, XI (May 6, 1971), 73-75.

419. ________. "Scandinavia: Information Coordinating Body," Science Policy News, III (September, 1971), 26-27.

420. Shore, H. "The Problems of a Small Scientific Community: The Norwegian Case," Minerva, VII (Spring, 1969), 399-425.

421. Vaigo, A. C. "Scandinavia's Response to the Science Boom," New Scientist, XXX (June 2, 1966), 600-601.

422. Wendt, Frantz. The Nordic Council and Cooperation in Scandinavia. Copenhagen: Munksgaard, 1959, 247.

LEADING QUESTIONS

1. What have been the historical relationships between government and science in the United Kingdom? How do these relationships compare with those characteristic of the United States, France, Germany, or the Soviet Union?

2. What is the "two cultures" thesis of Sir Charles P. Snow? Is its argument valid generally for modern society, for England, or for a limited segment of British society? What recent developments in the U. K. seem likely to influence the "two cultures" dichotomy in that country in the future?

3. What are the principal components of the machinery for the formulation and execution of science policy in the German government? How do they compare with instruments of science policy in the United States, France, United Kingdom, and the Soviet Union?

4. In what respects has the relation of science and technology to government differed in France from its relationship in the English-speaking countries? To what extent have French government-science relationships provided a model for other countries?

5. What obstacles have stood in the way of greater collaboration between the Western European nations in the field of science and technology? Has the degree of cooperation been increasing or decreasing?

6. What role has scientific and technological research and development played in the unification of Europe since 1945? What has been the contribution of European regional agencies for nuclear research and space technology?

7. What are the causes of the "Technological Gap" between Western Europe and the U.S.A.? Is it really one gap, or are there several gaps? What efforts are being undertaken, and could be undertaken, to narrow its extent?

8. What has been the function of the independent research institute in the development of European science? Are these comparable or analogous to institutions in the United States, the United Kingdom, or the Soviet Union?

9. How far can smaller European nations afford to invest in advanced scientific and technological research and development? Are they threatened by technological "imperialism"? What are their alternatives?

10. What valid comparisons or generalizations can be made regarding public support for science and technology in Western Europe and in the United States and the Soviet Union? Do the major Western European states tend to spend a higher or lower proportion of their national incomes on scientific research and development?

TOPIC 09 INTERNATIONAL TECHNOSCIENTIFIC COOPERATION

From its very beginnings science, as an intellectual enterprise, has transcended political boundaries. However with the growth of political ideologies, and notably with the growth of national states and nationalism, communication among scientists and scientific organizations has been complicated by international politics.

It therefore follows that the organization of world science has developed upon international lines. International scientific and technical organizations are generally organized upon the basis of national membership (unofficial as well as official). There is a tendency, however, for the organizations associated with the United Nations to assume an integrated world character rather than to emphasize their multinational basis (World Health Organization, World Meteorological Organization, and Food and Agriculture Organization).

Antecedents of permanent international scientific organizations were international scientific congresses, beginning in mid-19th century, and the establishment of international associations of scientists. In 1875, establishment of the International Bureau of Weights and Measures near Paris marked the beginning of permanent, operational, international technoscientific organizations. Today international technoscientific cooperation is organized around (1) temporary mission-oriented programs, (2) permanent nongovernmental professional associations, and (3) intergovernmental agencies. The first category comprises temporary congresses, committees, or programs constituted for a specific duration, such as the International Geophysical Year and the International Biological Program. Representing the second type of organization is the International Council of Scientific Unions and its constituent bodies. But there are many other technical, scientific, and professional organizations that serve in various ways to strengthen the matrix of the international scientific community. The third type is represented by the United Nations and its affiliates, and administers continuing scientific and technical programs.

The global extension and impact of the technoscientific culture make the growth of international and world organizations for scientific and technological purposes almost inevitable. Management in the oceans, in the atmosphere, in outer space, in the great international river systems lies in large measure beyond the capacity of individual national governments. The construction of feasible and effective organizations for the worldwide management of science and technology is one of the great challenges to human intelligence today.

The voluntary character of international cooperation is a source both of strength and of weakness to scientific and technological efforts on a global scale. Cooperative efforts, such as the World Weather Watch, serve the self-interest of all nations; but whenever cooperation impinges upon national military or economic advantage, its existence becomes precarious. The future of worldwide operational efforts in science and technology in all probability lies with transnational organizations responsible to a representative international body such as the United Nations rather than directly to national states.

TOPIC 09 INTERNATIONAL TECHNOSCIENTIFIC COOPERATION

Selected Basic Readings:

Haskins, C. P. "Science and Policy for a New Decade," Foreign Affairs, XLIX (January, 1971), 237-270.

Kovda, Victor A. "Search for a U. N. Science Policy," Bulletin of the Atomic Scientists, XXIV (March, 1968), 12-16.

Russell, Clifford S. and Hans H. Landsberg. "International Environmental Problems--A Taxonomy," Science, CLXXII (June 25, 1972), 1307-1314.

Salomon, Jean-Jacques. "The Internationale of Science," Science Studies, I (January, 1971), 23-42.

Skolnikoff, Eugene B. "Technology and the Future Growth of International Organizations," Technology Review, LXXIII (June, 1971), 39-47.

Supplementary and Substitute Readings:

Fox, W. T. "Science, Technology, and International Politics," International Studies Quarterly, XXI (March, 1968), 1-15.

Gardner, R. N. "Can the U.N. Lead the Environmental Parade?" American Journal of International Law, LXIV (September, 1970), 211-214.

OECD Observer. "International Technical Cooperation: Evaluation and Perspectives," OECD Observer, Number 29 (August, 1967), 3-6.

Pluhar, J. and B. Starnovsky. "Problems of International Cooperation in Research," Scientific World, XII (Number 1, 1968), 21-24.

Richardson, J. "UNESCO: Super-Ministry with Problems," Science Journal, V (August, 1969), 7-8.

Salomon, Jean-Jacques. "Introduction to Some Aspects of International Cooperation," in International Scientific Organizations, ed. by the Organization for Economic Cooperation and Development. Paris: OECD, 1965, 11-36.

TOPICAL OUTLINE	REFERENCE KEY
I. Science and Advanced Technology as International Enterprises	125, 162, 190, 198
A. The universal character of scientific knowledge	
B. The mobility of scientists and scientific and technological concepts	
C. International diffusion of technology	
II. The Necessity for International Technoscientific Cooperation	30, 32, 45, 76, 127, 132, 149, 218, 251, 288
A. The ultimate indivisibility and limitations of the planetary environment and the biosphere	40, 45, 155, 203, 292, 299
B. Limitations of national political control over the air and the oceans and over physical and biological interactions in the biosphere	18, 122, 151, 186, 269
C. International cooperation becomes necessary when a phenomenon	
1. Transcends political boundaries and cannot be controlled by unilateral action (e.g., weather reporting or modification, control of nuclear fallout, international telecommunications, fur seals, whales, oceanic conditions generally)	27, 28, 86, 100, 123, 124, 148, 175, 184, 202, 2[illegible], 259, 261, 262

2. Could only in part be controlled unilaterally, and international cooperation could greatly ease the burden and enhance the effectiveness of national action (e.g., medical quarantine, protection of migratory birds, exploration of outer space, aviation safety standards) 18, 81, 136, 200, 227

3. Could not be dealt with unless intellectual and material resources that are dispersed and unevenly concentrated around the world are brought into some form of cooperative relationship (e.g., technical assistance efforts to countries suffering from physical, economic, and social deterioration) 140, 262, 276, 301

III. Early Efforts toward International Organization for Purposes of Science or Technology 163

A. Early collaboration in observation and exploration
   1. Bessel's Sky Chart Project (started 1824)
   2. International Polar Year, 1882-83

B. International congresses
   1. 1847 International Congress of Economists--Brussels
   2. 1848 International Agriculture Congress--Brussels
   3. 1851 International Health Congress--Paris
   4. 1853 International Statistical Congress--Brussels
   5. 1860 International Congress of Chemistry--Karlsruhe
   6. 1862 International Congress of Geodesy--Berlin

C. International associations
   1. 1861 Universal Society of Ophthalmology--Paris

2. 1872 International Meteorological Committee--Leipzig
3. 1900 International Association of Academies--Gottingen

D. International bureaux
1. 1875 International Bureau of Weights and Measures--Paris
2. 1921 International Hydrographic Bureau--Monte Carlo

E. Research stations
1. Naples Zoological Station--1870
2. Jungfraujoch Scientific Station--1930

F. Scientific organizations under the League of Nations 254

IV. Contemporary International Organizations 179, 240, 248, 249, 272

A. International organizations--U.N. group (ultimate universality?) 40, 97, 298
1. United Nations--its committees and affiliated organizations 118
a. United Nations Educational, Scientific, and Cultural Organization, UNESCO--1945 41, 50, 146, 211, 236
b. Food and Agriculture Organization, FAO--1945 98, 139, 140, 225, 304
c. World Health Organization, WHO--1946 3, 72, 73, 174, 213, 300
d. World Meteorological Organization, WMO--1947 46, 204
e. International Atomic Energy Agency, IAEA--1956 5, 153, 173

f. International Civil Aviation Organization, ICAO

B. Other intergovernmental-international organizations
1. International Computation Centre, ICC--1961
2. International Institute of Refrigeration, IIR--1920
3. International Telecommunication Union, ITU — 69, 218
4. Intergovernmental Maritime Consultative Organization, IMCO
5. Permanent Commission of the International Fisheries Convention--1946
6. Intergovernmental Oceanographic Commission, IOC--1960-61

C. International scientific unions and associations
1. International Council of Scientific Unions--founded 1919 as the International Research Council and re-established as ICSU in 1931 — 1, 4, 12, 89, 229
   a. Fifteen (1966) constituent unions — 93
   b. Fifty-seven (1964) national members (represented by national academy, research council, or directly by a government)
   c. Scientific committees
      (1) Committee on Space Research, COSPAR--1958 — 38, 256
      (2) Scientific Committee on Oceanic Research, SCOR--1957
      (3) Scientific Committee on Antarctic Research, SCAR--1958
      (4) Scientific Committee on Problems of Environment, SCOPE--1970 — 306
   d. Inter-union committees (limited task and duration),
      (1) International Geophysical Committee, CIG--1959
      (2) Committee on Frequency Allocations for Radio and Space Science, IUCAF

- e. Special committees
  - (1) Comite Spécial de l'Année Géophysique Internationale, CSAGI
  - (2) Committee for the International Years of the Quiet Sun, IQSY--1964-65 — 256
  - (3) Committee for the International Biological Programm SCIBP — 242
- f. Permanent services
  - (1) ICSU Abstracting Board--1953
  - (2) Federation of Astronomical and Geophysical Services, FAGS--1956

2. Other international unions, federations, and associations — 248, 305
   - a. Semi-governmental--some governmental involvement or support: e.g., International Union for the Conservation of Nature and Natural Resources, IUCN; International Union of Forest Research Organizations — 4, 6, 230
   - b. Non-governmental professional: e.g., Council for International Organization of Medical Sciences, CIOMS; The International College of Surgeons; Union of International Engineering Organizations, UIEO

V. The Process of International Cooperation and Control — 23, 34, 179, 306, 311

A. The structure of international cooperation in science and technology — 293, 309

1. International organizations (limited participation)
2. International organizations (potential universal participation) — 97
   - a. The United Nations and affiliated organizations — 62, 298
   - b. Other intergovernmental organizations — 22
3. International semi-governmental organizations — 6
4. International non-governmental organizations

VI. Some Cases of International Scientific Cooperation	
A. International cooperation in scientific research--special programs	196
1. International Polar Year, 1932-33	
2. International Geophysical Year, 1957-58	126, 260
3. International Years of the Quiet Sun, 1964-65	7, 143
4. International Biological Program	56, 57, 120, 177, 191, 288
5. International Hydrological Decade	
6. Indian Ocean Expedition	
7. Global Atmospheric Research Program--GARP	116, 243
8. International Decade of Ocean Exploration	88, 187, 241
9. The United Nations Conference on the Human Environment (1972)	4, 63, 64, 107 306, 309, 310
B. International technical cooperation--continuing efforts	30, 32, 67, 76, 92, 147, 279, 282
1. Outer space exploration	17, 38, 43, 58, 61, 79, 105, 136, 170, 205
2. Peaceful uses of atomic energy	3[illegible], 133, 172, 187, 201, 235
3. Allocation of radio-wave bands	70
4. Communication satellites	31, 70, 123, 165, 168, 261, 262, 268, 277, 278
5. Protection of endangered species	111, 175, 227, 258, 302, 303
6. Improved food production	68, 78, 140, 266, 284, 304
7. Economic development	271, 274, 276
8. Disease prevention and control	36, 156, 166, 199, 233, 234, 281, 301
9. Education	55, 76, 118, 270

VIII. Problems of International Scientific Cooperation — 35, 94, 142, 151, 163, 164, 255, 260, 286, 287, 289

A. National sovereignty, exclusiveness, and self-interest — 52, 102, 169, 193, 200

1. Military or security considerations — 49, 209, 210, 216
2. National rivalry (U.S.A.-U.S.S.R.) — 8, 54, 124, 144, 231
3. Fear of precedent-setting — 209
4. Fear and suspicion of "scientific" imperialism — 16, 98, 235

B. Political indifference — 255

1. Refusal of governments to lend support to international scientific activity on legal and political grounds
2. Resistance of political leadership to commitments where no political payoff is in sight

C. Ideological resistance and social conservatism

1. Population control — 281
2. Efficient food production — 284
3. Natural resource exploitation — 104, 262, 266, 280
4. Obsolete educational systems — 76, 118

D. Inadequate organization within national governments for effective cooperation in scientific matters — 163, 192, 271

1. Science in advanced nations under political restraint
2. Division of responsibility for scientific activities in various countries among different ministries and agencies of government. Delegation from the same nation to different conferences can be subject to inconsistent instructions
3. No real scientific establishment in many "new" nations

4. Organizations tend to follow own laws of growth. Increasing expense poses problems especially for smaller countries

E. Inadequate technoscientific or techo-economic solutions to the control problem
   1. Atomic waste disposal — 128, 133
   2. Weather modification
   3. Population control — 281
   4. Drug abuse — 99, 254

F. Lack of international machinery for effective control over political or economic misuse of science or technology — 117
   1. Misuse or destruction of irreplaceable national resources, e.g., oceans, wildlife, topsoil — 28[illegible]2, 175, 25[illegible]
   2. Activities in outer space — 35, 219

BIBLIOGRAPHY

General References: Articles

1. Atwood, Wallace W. "International Council of Scientific Unions," Science, CXXVIII (December, 1958), 1558-1561.

2. Auger, Pierre. "Scientific Cooperation in Western Europe," Minerva, I (Summer, 1963), 428-438.

3. Aykroyd, W. R. "International Health--A Retrospective Memoir," Perspectives in Biology and Medicine, XI (Winter, 1968), 273-285.

4. Bazell, Robert J. "Human Environment Conference: The Rush for Influence," Science, CLXXIV (October 22, 1971), 390-391.

5. Bechhoefer, Bernard C. "The International Atomic Energy Agency," Bulletin of the Atomic Scientists, XIV (April, 1958), 147-150.

6. Berwick, E. J. H. "The International Union for Conservation of Nature and Natural Resources: Current Activities and Situations," Biological Conservation, I (April, 1969), 191-199.

7. Beynon, W. J. G. "The International Years of the Quiet Sun," Advancement of Science, XXII (July, 1965), 167-176.

8. Blagonravov, Anatoly. "It Does Not Matter Who Reaches the Moon First...," UNESCO Courier, XIX (May, 1966), 7-12.

9. Bok, Bart J. "Science in International Cooperation," Science, CXXI (June 17, 1955), 843-847.

10. Borgese, Elizabeth M. "A Center Report/The Republic of the Deep Seas," Center Magazine, I (May, 1968), 18-27.

11. Brabyn, Howard. "UNISIST for World Science," New Scientist and Science Journal, XLIX (March 11, 1971), 568-569.

12. Brown, Harrison S. "International Cooperation: The New ICSU Program on Critical Data," Science, CLVI (May 12, 1967), 751-754.

13. Buchinger, Maria. "International Cooperation in Natural Area Preservation," AIBS Bulletin (BioScience), XVIII (May, 1968), 388-392.

14. Bulletin of the Atomic Scientists. "Anarctica since the IGY," Bulletin of the Atomic Scientists, XXVI (December, 1970), entire issue.

15. Cade, J. A. "The International Institute for the Management of Technology," OECD Observer, Number 47 (August, 1970), 44-49.

16. Calder, Nigel. "The Controversy about World Health Research," New Scientist, XXV (January 28, 1965), 207-208.

17. ________. "Space Techniques for Poor Countries," New Scientist, XXXIX (August 29, 1968), 445-446.

18. Carter, Luther J. "Deep Seabed: 'Who Should Control It?' U.N. Asks," Science, CLIX (January 5, 1968), 66-68.

19. Chapman, Sydney. "The International Geophysical Year," Advancement of Science, XIII (March, 1957), 259-268.

20. Cheever, D. C. "Marine Science and Ocean Politics," Bulletin of the Atomic Scientists, XXVI (February, 1970), 22; 29-34.

21. Chemical and Engineering News. "ACS Links with Germans for Information Network," Chemical and Engineering News, XLVII (September 22, 1969), 15-16.

22. ________. "NATO Programs Support Scientific Research," Chemical and Engineering News, XLIX (May 10, 1971), 50-52.

23. Chinn, H. I. "International Scientific Cooperation," Bulletin of the Atomic Scientists, XXVI (November, 1969), 34-35; 47.

24. Clemens, W. C., Jr. "The Ecology of Weaponry," Bulletin of the Atomic Scientists, XXVI (September, 1970), 27-31.

25. Cockcroft, John. "Scientific Collaboration in Europe," New Scientist, XVII (January 24, 1963), 170-172.

26. Colbans, H. "Control and Use of Scientific Information," Nature, CCXXVI (April 25, 1970), 319-321.

27. Crittenden, E. C. "Some Problems in National and International Standards," Scientific Monthly, LXXVIII (May, 1954), 278-282.

28. Crutchfield, James and Giulio Pontecorvo. "Crisis in the Fisheries," Bulletin of the Atomic Scientists, XXVIII (November, 1962), 18-20.

29. Curtis, Roger W. "International Conferences," International Science and Technology, Number 11 (November, 1962), 38-41.

30. Daddario, Emilio Q. "National Science Policy--Prelude to Global Cooperation," Bulletin of the Atomic Scientists, XXVII (June, 1971), 21-24.

31. D'Arcy, J. "Challenge to Cooperation," Saturday Review, LIII (October 24, 1970), 24-25; 72-73.

32. David, Edward E., Jr. "Views on the Need for International Science Policy and Concepts for International Scientific Cooperation," Congressional Record, CXVII (February 1, 1971), E320-E322.

33. Dedijer, Stevan. "International Comparisons of Science," New Scientist, XXI (February 20, 1964), 561-564.

34. Dedijer, Stevan and A. J. Longrigg. "A Model of Foreign Research Policy," Scientific World, XIII (Number 1, 1969), 17-21.

35. Deutsch, Karl W. "The Impact of Science and Technology on International Politics," Daedalus, LXXXVIII (Fall, 1959), 669-685.

36. Diehl, Harold S. "Health as an Instrument of International Policy," Journal of the American Medical Association, CLXI (August 4, 1956), 1371-1375.

37. Doumani, George. "Science Policy for Antarctica," Bulletin of the Atomic Scientists, XXIV (April, 1968), 39-45.

38. Eisendrath, C. R. "To Internationalize Outer Space Research," Technology Review, LXXII (January, 1970), 36-39.

39. Eklund, Sigvard. "The International Atom," Bulletin of the Atomic Scientists, XXVI (June, 1970), 56-61.

40. Eldin, G. "The Need for Intergovernmental Cooperation and Coordination Regarding the Environment," OECD Observer, L (February, 1971), 3-7.

41. Ellis, William N. "The Crisis in Science and UNESCO," Bulletin of the Atomic Scientists, XXVII (February, 1971), 33-35.

42. Ellyett, C. D., V. V. Lincoln, and H. P. Smith. "Growth and Future Plans for World Data Centre," Nature, CCXIX (August 24, 1968), 787-790.

43. Elson, B. M. "Other Nations to Use Space Station," Aviation Week and Space Technology, XCIII (September 28, 1970), 50-56.

44. Esman, Milton J. and John D. Montgomery. "Systems Approaches to Technical Cooperation: The Role of Development Administration," Public Administration Review, XXIX (September-October, 1969), 507-539.

45. Estep, Samuel D. "International Lawmakers in a Technological World: Space, Communications, and Nuclear Energy," George Washington Law Review, XXXIII (October, 1964), 162-180.

46. External Affairs. "The World Meteorological Organization," External Affairs, V (September, 1961), 306-311.

47. Fedora, E. K. "World Weather Watch," WMO Bulletin, XV (October, 1966), 194-198.

48. Felbeck, D. K. "International Cooperation in Materials Research," News Report: NAS-NRC, XI (March-April, 1961), 33-34.

49. Feld, Bernard T. "The Sorry History of Arms Control," Bulletin of the Atomic Scientists, XXVI (September, 1970), 22-26.

50. ________. "UNESCO Science and Technology," Bulletin of the Atomic Scientists, XX (November, 1964), 31-34.

51. Findlay, John W. "Practicing the Science of Radio Astronomy," Science, CXXXVII (September 14, 1962), 829-835.

52. Fink, D. E. "World Unity Urged on Space Programs," Aviation Week and Space Technology, LXXXVII (October 2, 1967), 21-22.

53. Fonselius, Stig H. "Stagnant Sea," Environment, XII (July-August, 1970), 2-3; 7-11; 40-48.

54. Fox, W. T. "Science, Technology, and International Politics," International Studies Quarterly, XXI (March, 1968), 1-15.

55. Frase, Robert W. and Sanborn C. Brown. "The Florence Agreement: On the Importation of Educational, Scientific, and Cultural Materials," Physics Today, XIII (February, 1960), 26-30.

56. Friedman, S. "IBP and the Legislature," AIBS Bulletin (BioScience), XIX (May, 1969), 459-460.

57. ________. "Realignment of IBP Programs," AIBS Bulletin (BioScience), XIX (February, 1969), 153-154.

58. Frutkin, A. W. "International Cooperation in Space," Science, CLXIX (July 24, 1970), 333-338.

59. Garcia, Rolando. "The Global Atmospheric Research Programme," WMO Bulletin, XVIII (July, 1969), 186-188.

60. Gardner, Richard N. "Can the U.N. Lead the Environment Parade?" American Journal of International Law, LXIV (September, 1970), 211-214.

61. ________. "Cooperation in Outer Space," Foreign Affairs, XLI (January, 1963), 351-352.

62. ________. "U.N. as Policeman," Saturday Review, LIV (August 7, 1971), 47-50.

63. Gillette, Robert. "Human Environment Conference: Citizen Advisers Muddle Through," Science, CLXXIV (October 29, 1971), 479-481.

64. ________. "Human Environment Conference: Slow Start toward Stockholm," Science, CLXXII (June 4, 1971), 1011-1013.

65. Gould, Lawrence M. "Antarctica--Continent of International Science," Science, CL (December, 1965), 1775-1781.

66. Grant, R. P., C. P. Huttrer, and C. G. Metzner. "Biomedical Science in Europe," Science, CXLVI (October 23, 1964), 493-501.

67. Greenberg, Daniel S. "Soviets, West Discuss 'Think Tank'," Science, CLXVI (December 12, 1969), 1382.

68. Gregory, Gene. "The New Food Revolution," UNESCO Courier, XXII (March, 1969), 4-12; 32.

69. Gross, Gerald C. "ITU and the Future of International Telecommunications," United Nations Monthly Chronicle, II (May, 1965), 75-78.

70. Gunn, H. N., Jr. "New Technology for Public Communications," Technology Review, LXXIII (July-August, 1971), 24-29.

71. Häefele, W. "The International Implications of Modern Technology," NATO's Fifteen Nations, XII (December, 1967-January, 1968), 55-56; 60; 62; 64; 66.

72. Hall, Durward G. "The WHO," Journal of the American Medical Association, CLXXXII (October 13, 1962), 168-171.

73. Handler, J. "The Work of the World Health Organization," International Review of Administrative Sciences, XXIX (Number 2, 1963), 167-169.

74. Hanessian, J., Jr. "International Aspects of Earth Resources Survey Satellite Programs," Journal of the British Interplanetary Society, XXIII (Spring, 1970), 533-557.

75. Harvey, Bartlett. "The World Impact of American Technology," Annals of the American Academy of Political and Social Science, CCCLXVI (July, 1966), 41-50.

76. Haskins, C. P. "Science and Policy for a New Decade," Foreign Affairs, XLIX (January, 1971), 237-270.

77. Havens, William W., Jr., et al. "The European-American Nuclear Data Committee," Physics Today, XX (May, 1967), 35-42.

78. Haverstock, Nathan A. and Richard C. Schroeder. "Green Revolution," Editorial Research Reports (March 25, 1970), 219-238.

79. Hersey, Irwin. "U.N. Holds Its First Space Conference," Astronautics and Aeronautics, VI (October, 1968), 86-91.

80. Higginson, John. "International Research: Its Role in Environmental Biology," Science, CLXX (November 27, 1970), 935-939.

81. Hildred, William P. "International Air Transport Problems," Advancement of Science, XVI (December, 1959), 165-185.

82. Hirsch, Etienne. "A Guide to EURATOM," Bulletin of the Atomic Scientists, XV (June, 1959), 250-252; 265.

83. Hughes, Donald J. "International Cooperation in Nuclear Power," Scientific American, CXCII (April, 1955), 31-35.

84. Hulst, H. C. van de. "International Space Cooperation," Bulletin of the Atomic Scientists, XVII (May-June, 1961), 233-236.

85. Hutchisson, Elmer. "The Role of International Scientific Organizations in Improving Scientific Documentation," Physics Today, XV (September, 1962), 24-26.

86. Huth, Arno G. "Cooperative Radio Agreements," International Organization, VI (August, 1952), 396-406.

87. Jamison, A. "IHD: International Symbol of 'National Embarrassment'?" Science, CLXI (September 13, 1968), 1118-1119.

88. Jennings, F. D. "International Decade of Ocean Exploration," Congressional Record, CXVII (March 9, 1971), S2703-S2704.

89. Jones, Harold S. "The International Council of Scientific Unions," Endeavor, XVIII (April, 1959), 88-92.

90. Jordan, L. "Scientific and Technical Relations among Eastern European Communist Countries," Minerva, VIII (July, 1970), 376-395.

91. Kahn, R. S. "Expanded Role in Space Sought for U.S.," Aviation Week and Space Technology, XC (May 26, 1969), 57; 59; 61.

92. Kash, Don E. "The Tyranny of Realism," Bulletin of the Atomic Scientists, XXIII (February, 1967), 16-20.

93. Kerwin, Larkin. "The International Union of Pure and Applied Physics," Physics Today, XXII (May, 1969), 53-55.

94. King, Alexander. "International Scientific Cooperation--Its Possibilities and Limitations," Impact of Science on Society, IV (Winter, 1953), 189-220.

95. King, Alexander and J. R. Gass. "Science and Education in OECD," OECD Observer, Special Issue on Science, (February, 1966), 21-32.

96. Kohler, M. A. "The International Hydrological Decade," UNO Bulletin, XII (October, 1963), 193-197.

97. Kovda, Victor A. "Search for a U.N. Science Policy," Bulletin of the Atomic Scientists, XXIV (March, 1968), 12-16.

98. Lamy, Xavier. "Overcoming Suspicion," Ceres, II (September-October, 1969), 42-47.

99. Lande, Adolf. "The Single Convention on Narcotic Drugs, 1961," International Organization, XVI (Autumn, 1962), 776-797.

100. Langlo, K. "A New Look in Meteorology: The World Weather Watch," Impact of Science on Society, XVI (Number 2, 1966), 65-92.

101. Lee, Gordon C. "The University-USAID Relationship," Public Administration Review, XXIX (May-June, 1969), 276-285.

102. Lepawsky, Albert. "International Development of River Resources," International Affairs, XXXIX (October, 1963), 533-550.

103. Loftas, Tony. "Mediterranean Pollution--Another Year of Neglect," New Scientist and Science Journal, LI (July 15, 1971), 144-145.

104. Logsdon, J. M. and J. Hanessian, Jr. "Earth-Resource Surveys--An International Framework Begins to Develop," Astronautics and Aeronautics, IX (September, 1971), 30-35.

105. Low, G. M. "International Aspects of Our Space Program," Congressional Record, CXVII (January 27, 1971), E198-E199.

106. Lust, R. "The European Space Research Organization," Science, CXLIX (July 23, 1965), 394-397.

107. McClory, R. "International Conference on Problems of the Environment," Congressional Record, CXVII (June 9, 1971), E5620-E5621.

108. McDonnell, R. M. "Ensuring Safety in Flight: An International Affair," United Nations Review, IX (February, 1962), 20-21.

109. McElheny, Victor K. "The Cooperative Space Research Agency," Science, CXLIV (April 17, 1964), 276-277.

110. ________. "East-West Exchanges of Technology Increase Rapidly," Science, CLIII (July 8, 1966), 156-158.

111. McHugh, John L. "The United States and World Whale Resources," AIBS Bulletin (BioScience), XIX (December, 1969), 1075-1078.

112. McKnight, Allan. "International Regulation of Science and Technology," International Journal, XV (Autumn, 1970), 745-746.

113. McNeil, Elton B. "An International University," Bulletin of the Atomic Scientists, XVIII (October, 1962), 23-24.

114. Malina, Frank J. "International Cooperation in Science: The Work of UNESCO," Bulletin of the Atomic Scientists, VI (April, 1960), 121-125.

115. Malmgren, H. B. "Environmental Control and the International Economy," Congressional Record, CXVII (March 11, 1971), S3034-S3037.

116. Mason, B. J. "Global Atmospheric Research Programme," Nature, CCXXXIII (October 8, 1971), 382-388.

117. Mehren, Robert B. "The International Atomic Energy Agency in World Politics," Journal of International Affairs, XIII (Winter, 1959), 57-69.

118. Michio, Nagai. "UN International University in a Changing World," Japan Quarterly, XVIII (October-December, 1971), 402-407.

119. Miller, G. P. "A Joint House-Senate Colloquium on International Environmental Science," Congressional Record, CXVII (April 7, 1971), E3006-E3007.

120. ________. "The Nation Needs the International Biological Program," Bulletin of the Ecological Society of America, XLIX (November, 1968), 142-147.

121. Nace, Raymond L. "Water: A Common Problem," Bulletin of the Atomic Scientists, XXI (January, 1965), 32-34.

122. ________. "Water Resources: A Global Problem with Local Roots," Environmental Science and Technology, I (July, 1967), 550-560.

123. Nature. "Decisions in Principle," Nature, CCXXXII (July 23, 1971), 213.

124. Neild, Robert and J. P. Ruina. "A Comprehensive Ban on Nuclear Testing," Science, CLXXV (January 14, 1972), 141-416.

125. Noyes, W. Albert, Jr. "The Place of the Scholar in International Affairs," American Scientist, XXXVIII (January, 1950), 120-126.

126. Odishaw, Hugh. "The International Geophysical Year and World Politics," Journal of International Affairs, XIII (Winter, 1959), 47-56.

127. OECD Observer. "International Technical Cooperation: Evaluation and Perspectives," OECD Observer, Number 29 (August, 1967), 3-6.

128. ______. "OECD Convention on Liability for Nuclear Damage," OECD Observer, Number 22 (June, 1966), 36-39.

129. ______. "OECD and the Environment," OECD Observer, LIII (August, 1971), 19-26.

130. Oliver, Jack and Leonard Murphy. "WWNSS: Seismology's Global Network of Observing Stations," Science, CLXXIV (October 15, 1971), 254-261.

131. Organization for Economic Cooperation and Development. "The Influence of Science and Technology in Present-Day Foreign Policy," Science Policy Information, III (October, 1967), 47-48.

132. ______. "The Need for European Cooperation in Research," Science Policy Information, III (October, 1967), 42-44.

133. Osborn, Frederick H. "Control of Atomic Energy: An International Problem," Bulletin of the Atomic Scientists, V (August-September, 1949), 251-254.

134. Parsons, E. "International Technical Cooperation: Evaluation and Perspectives," OECD Observer, Number 29 (August, 1967), 3-9.

135. Peavey, Ross C. and Lawrence M. Gould. "Antarctica, International Land of Science," UNESCO Courier, XV (January, 1962), 9-14.

136. Percy, Charles H. "International Cooperation in Space," Congressional Record, CXVII (March 16, 1971), S3270-S3271.

137. Peters, Randolph and Nicolai Herlofson. "The Future of International Science," New Scientist, V (September 14, 1961), 665-667.

138. Petrullo, L. "Government Sponsorship of Overseas Research," American Psychologist, XXIII (February, 1968), 108-111.

139. Phillips, Ralph W. "Food and Agriculture Organization Completes 15 Years," Science, CXXXII (September 30, 1960), 871-881.

140. ________. "International Cooperation to Improve World Agriculture," Scientific Monthly, LXXIX (September, 1954), 154-164.

141. Pijoan, M. and F. Trowbridge von Baur. "Science as the Common Ground for Relations between Nations," Scientific Monthly, LXIII (August, 1946), 137-140.

142. Pluhar, J. and B. Starnovsky. "Problems of International Cooperation in Research," Scientific World, XII (Winter, 1968), 21-24.

143. Pushkov, Nicolai and Boris Silkin. "The Years of the Quiet Sun," UNESCO Courier, XIX (September, 1966), 22-28.

144. Rabinowitch, Eugene. "On the Sochi Conference," Bulletin of the Atomic Scientists, XXVI (April, 1970), 18-20.

145. Revelle, Roger. "International Cooperation in Marine Sciences," Science, CXXVI (December 27, 1957), 1319-1323.

146. Richardson, J. "UNESCO: Super-Ministry with Problems," Science Journal, V (August, 1969), 7-8.

147. Roberts, W. O. "After the Moon, the Earth!" Science, CLXVII (January 2, 1970), 11-16.

148. Robinson, George D. "Global Environment Monitoring," Technology Review, LXXIII (May, 1971), 19-27.

149. Rogers, William. "Growing Ties between Science and Foreign Policy," Department of State Bulletin, LXIV (June 14, 1971), 776-778.

150. Rosenfeld, Stephen S. "Soviet-American Exchanges--Tit-for-Tat Goodwill," Science, CXLIII (March 27, 1964), 1413-1417.

151. Rosseau, Charles. "Scientific Progress and the Evolution of International Law," Impact of Science on Society, V (June, 1954), 71-92.

152. Roth, W. V., Jr. "International Conference on Ocean Dumping," Congressional Record, CXVII (April 1, 1971), S4383-S4386.

153. Rubinstein, Alvin Z. "On IAEA's Future," Bulletin of the Atomic Scientists, XXI (January, 1965), 25-27.

154. Rugg, Dean S. "The International Map of the World," Scientific Monthly, LXXII (April, 1951), 233-240.

155. Russell, Clifford S. and Hans H. Landsberg. "International Environmental Problems--A Taxonomy," Science, CLXXII (June 25, 1971), 1307-1314.

156. Russell, Paul F. "International Preventive Medicine," Scientific Monthly, LXXI (December, 1950), 393-400.

157. Salam, Abdus. "Interaction at Trieste," New Scientist, XXVIII (December 2, 1965), 672-674.

158. ________. "The International Center for Theoretical Physics," Physics Today, XVIII (March, 1965), 52-53.

159. ________. "A New Center for Physics," Bulletin of the Atomic Scientists, XXI (December, 1965), 25-27.

160. ________. "The United Nations and the International World of Physics," Bulletin of the Atomic Scientists, XXIV (February, 1968), 14-15.

161. Salomon, Jean-Jacques. "International Scientific Policy," Minerva, II (Summer, 1964), 411-434.

162. ________. "The Internationale of Science," Science Studies, I (January, 1971), 23-42.

163. ________. "Introduction to Some Aspects of International Cooperation," in International Scientific Organizations, ed. by Organization for Economic Cooperation and Development. Paris: OECD, 1965, 11-36.

164. ________. "Problems of International Cooperation in Scientific and Technical Research," OECD Observer, Special Issue on Science, (February, 1966), 43-48.

165. Samuelson, R. J. "INTELSAT: Flying High, but Future Course Uncertain," Science, CLXIV (April 4, 1969), 56-57.

166. Scheele, Leonard A. "Public Health and Foreign Policy," Annals of the American Academy of Political and Social Science, CCLXXVIII (November, 1951), 62-72.

167. Schilling, Warner R. "Science, Technology, and Foreign Policy," Journal of International Affairs, XIII (Winter, 1959), 7-18.

168. Schramm, Wilber. "Communication Satellites: The New Music of the Spheres," UNESCO Courier, XXI (February, 1968), 24-29.

169. Schwartz, Leonard E. "When Is International Space Cooperation International?" Bulletin of the Atomic Scientists, XIX (June, 1963), 12-18.

170. Science. "Soviet-American Conference Urges Search for Other Worlds," Science, CLXXIV (October 8, 1971), 130-131.

171. Science Policy News. "International Cooperation in Social Science Research and Policy Organization," Science Policy News, I (March, 1970), 97-99.

172. Seaborg, Glenn T. "The Promise of the International Atomic Energy Agency," Science, CLVIII (October 13, 1967), 226-230.

173. Sharpe, Bernard W. "Nuclear Safeguards: The IAEA Program," Physics Today, XXII (November, 1969), 33-37.

174. Shimkin, Michael B. "The World Health Organization," Science, CIV (September 27, 1946), 281-283.

175. Simon, Noel. "Of Whales and Whaling," Science, CXLIX (August 25, 1965), 943-946.

176. Singer, S. Fred. "The First Global Weather Research: Its Questions and Possibilities," Astronautics and Aeronautics, VI (May, 1968), 30-35.

177. Sissakian, N. M. "International Cooperation in the Biological Sciences," Impact of Science on Society, XII (Number 3, 1962), 146-156.

178. ________. "The International Prospects of Science," UNESCO Courier, XVIII (March, 1965), 4-8.

179. Skolnikoff, Eugene B., "Technology and the Future Growth of International Organizations," Technology Review, LXXIII (June, 1971), 39-47.

180. Smith-Ross, R. L. "Allocation of Frequencies for Radio Astronomy and Space Sciences," Nature, CCIII (July 4, 1964), 7-11.

181. ________. "The International Scientific Radio Union," Nature, CXCIX (August 3, 1963), 436-437.

182. Spencer, D. L. "International Transfer of Technology," Modern Age, XII (Winter, 1967-68), 14-23.

183. Struve, Otto. "The International Astronomical Union," Science, CXVII (March 27, 1953), 315-318.

184. Taubenfeld, Howard J. "A Treaty for Antarctica," International Conciliation, Number 531 (1961), 245-322.

185. Thornton, Gerard. "Overseas Activities of the Royal Society," New Scientists, VII (July 14, 1960), 118-120.

186. Todd, W. M. and John Voss. "The Consortium of Academies: A New Way to Found International Scholarly Institutions," Bulletin of the Atomic Scientists, XXVII (February, 1971), 29-32.

187. United Nations Educational, Scientific, and Cultural Organization. "Peaceful Uses of the Atom," UNESCO Courier, XXI (July-August, 1968), 4-47.

188. U.S. Department of Commerce News. "EDS Named Lead Agency for Management of Data Gathered in International Decade of Ocean Exploration," U.S. Department of Commerce News (August 11, 1971), 1-2.

189. Visscher, Maurice B. "Role of Council for International Organizations in Medical Science," Science, CXXIII (February 24, 1956), 337.

190. Von Muralt, Alexander. "International and National Aspects of Science," Physics Today, VI (April, 1953), 4-6.

191. Waddington, Conrad H. "Mobilizing the World's Biologists," Bulletin of the Atomic Scientists, XIX (November, 1963), 39-41.

192. Waksman, Selman A. "Penalty of Isolationism," Science, CXXV (March 29, 1957), 585-587.

193. Walsh, John. "Arms Control and Disarmament: SALT, CCD, CTB, MBFR, etc.," Science, CLXXV (January 21, 1972), 281-282.

194. ________. "ESRO: Space Sciences Research in Europe Suffers Growing Pains," Science, CLVIII (October 13, 1967), 242-243.

195. ________. "EURATOM: After 10 Years, Still Seeking the Way," Science, CLVIII (October 6, 1967), 95-98.

196. ________. "International Science Activities: Some New Vistas Open," Science, CLII (June 17, 1966), 1605-1607.

197. Weinberg, Alvin M. "Can Technology Stabilize the World Order?" Public Administration Review, XXVII (December, 1967), 460-464.

198. ________. "Prospects in International Science," Bulletin of the Atomic Scientists, XIV (December, 1958), 402-404.

199. Weir, John M. "The United States Foreign Medical Aid Program," New England Journal of Medicine, CCLXX (February 13, 1964), 344-351.

200. Wiesner, Jerome B. "Inspection for Disarmament," in his Where Science and Politics Meet. New York: McGraw-Hill, 1965, 247-278.

201. Willrich, Mason. "Safeguarding Atoms for Peace," American Journal of International Law, LX (January, 1966), 34-54.

202. Wilson, T. W., Jr. "The Environment: Do the Polluted Clouds Have a Silver Lining?" Futurist, V (February, 1971), 26-29.

203. Wolman, A. "Pollution as an International Issue," Foreign Affairs, XLVII (October, 1968), 164-175.

204. World Meteorological Organization. "First Session of the Joint GARP Organizing Committee," WMO Bulletin, XVII (July, 1968), 126-130.

205. Wright, Christopher. "Scientific Progress and the Government of Outer Space," Journal of International Affairs, XIII (Winter, 1959), 78-92.

206. ________. "United Nations and Space," Bulletin of the Atomic Scientists, XVII (May-June, 1961), 236-240.

207. Ziman, John M. "The 'Winter College' Format," Science, CLXXI (January 29, 1971), 352-354.

208. Zwemer, Raymund L. "The UNESCO Program for Scientific Research," AIBS Bulletin, VII (January, 1957), 8-10.

General References: Books

209. Barnaby, C. F., ed. Preventing the Spread of Nuclear Weapons. London: Souvenir Press, 1969, 374.

210. Barnaby, C. F. and A. Boserup, eds. Implications of Anti-Ballistic Systems. London: Souvenir Press, 1969, 246.

211. Behrman, Daniel. Web of Progress: UNESCO at Work in Science and Technology. Paris: UNESCO, 1964, 103.

212. Berkner, Lloyd V. Science and Foreign Relations: International Flow of Scientific and Technological Information. Washington, D.C.: U.S. Department of State, 1950, 170.

213. Berkov, Robert. The World Health Organization: A Study in Decentralized International Administration. Paris: Librarie Minard, and Geneva: Librarie E. Droz, 1957, 173.

214. Borgese, Elizabeth M. The Ocean Regime. Santa Barbara, California: Center for the Study of Democratic Institutions, 1968, 40.

215. Braunias, Karl and Peter Meraviglia, eds. Modern Science and the Tasks of Diplomacy. (International Seminar for Diplomats, Klessheim, 1964). Graz, Austria: Verlag Styria, 1965. (Note especially David A. Davis, "Geophysics and Its Impact on International Affairs," 103-116.)

216. Bush, Vannevar. Modern Arms and Free Men. Cambridge, Massachusetts: M.I.T. Press, 1968, 273. (Original edition published by Simon and Schuster, 1949.)

217. Chapman, J. D., ed. The International River Basin. Vancouver: University of British Columbia, 1963, 53.

218. Codding, George A. The International Telecommunications Union: An Experiment in International Cooperation. Leiden: E.J. Brill, 1952, 505.

219. Cohen, Maxwell, ed. Law and Politics in Space: Specific and Urgent Problems in the Law of Outer Space. Montreal: McGill University Press, 1964, 221.

220. Cristy, Francis T., Jr. and Anthony Scott. The Common Wealth in Ocean Fisheries. Baltimore: Johns Hopkins Press, 1966, 296.

221. Edwards, David V. Arms Control in International Politics. New York: Holt, Rinehart, and Winston, 1969, 200.

222. Frutkin, Arnold W. International Cooperation in Space. Englewood Cliffs, New Jersey: Prentice-Hall, 1965, 186.

223. Goldsen, Joseph M., ed. Outer Space in World Politics. New York: Praeger, 1963, 180.

224. Haley, Andrew G. Space Law and Government. New York: Appleton-Century-Crofts, 1963, 584.

225. Hambidge, Gove. The Story of FAO. New York: Van Nostrand, 1955, 330.

226. Haskins, Caryl P. The Scientific Revolution and World Politics. New York: Harper and Row, 1964, 115.

227. Hayden, Sherman S. The International Protection of Wildlife. New York: Columbia University Press, 1942, 246.

228. Institute for Politics and Planning. Multi-National Investment in Ocean Activities. Arlington, Virginia: Institute for Politics and Planning, 1969, 89.

229. International Council of Scientific Unions. A Description of the International Council of Scientific Unions: A Description of the Council, of Its Commissions, and of Its Affiliated Scientific Unions and Commissions with Some Account of Their History and Scientific Activities. Cambridge, England: University Press, 1950.

230. International Union for Conservation of Nature and Natural Resources. IUCN--Yearbook, 1970, ed. by Robert I. Standish. Morges, Switzerland: IUNC, 1971, 98.

231. Jacobson, Harold K. and Eric Stein. Diplomats, Scientists, and Politicians: The United States and the Nuclear Test Ban Negotiations. Ann Arbor: University of Michigan Press, 1966, 538.

232. Jessup, Philip C. and Howard J. Taubenfeld. Controls for Outer Space and the Antarctic Analogy. New York: Columbia University Press, 1959, 379.

233. John E. Fogarty International Center for Advanced Study in the Health Sciences. Bethesda, Maryland: Department of Health, Education, and Welfare, 1971, 14.

234. ________. National Institutes of Health Annual Report of International Activities, Fiscal Year 1970. Bethesda, Maryland: Department of Health, Education, and Welfare, 1970, 147.

235. Kramish, Arnold. The Peaceful Atom in Foreign Policy. New York: Harper and Row, 1963, 276.

236. Laves, Walter H. C. and Charles Thompson. UNESCO: Purpose, Progress, Prospects. Bloomington: Indiana University Press, 1957, 357.

237. McDougal, Myres S. and W. T. Burke. The Public Order of the Oceans: A Contemporary International Law of the Sea. New Haven, Connecticut: Yale University Press, 1962, 1226.

238. McDougal, Myres S., Harold D. Lasswell, and Ivan A. Vlasic. Law and Public Order in Space. New Haven, Connecticut: Yale University Press, 1964, 1147.

239. Morgan, Murray. Doctors to the World. New York: Viking Press, 1958, 271.

240. Murra, Kathleen O. International Scientific Organizations: A Guide to Their Library, Documentation, and Information Services. Library of Congress Publication 62-64648. Washington, D.C.: U.S. Government Printing Office, 1962, 794.

241. National Academy of Sciences. National Academy of Engineering. An Oceanic Quest: The International Decade of Ocean Exploration. Washington, D.C.: National Academy of Sciences, 1969, 115.

242. National Academy of Sciences - National Research Council. National Academy of Engineering, Division of Biology and Agriculture. U.S. Participation in the International Biological Program. Washington, D.C.: U.S. Government Printing Office, 1967, 26.

243. ________. Geophysics Research Board. An Outline of International Programs in the Atmospheric Sciences. Washington, D.C.: U.S. Government Printing Office, 1963, 95. (NSF Publication 1085)

244. ________. Committee for Global Atmospheric Research Program, Division of Physical Sciences. Plan for U.S. Pariticipation in the Global Atmospheric Research Program. Washington, D.C.: U.S. Government Printing Office, 1969, 79.

245. Needham, Joseph. Science and International Relations. Oxford: Blackwell, 1949, 30.

246. Noyes, W. Albert, Jr. Science on the National and International Scenes. Lincoln: University of Nebraska Press, 1956, 92.

247. Ogburn, William F., ed. Technology and International Relations. Chicago: University of Chicago Press, 1949, 148.

248. Organization for Economic Cooperation and Development. International Scientific Organizations. Paris: OECD, 1965, 286. Supplement, January, 1966, 86.

249. ________. Ministers Talk about Science--A Summary and Review of the First Ministerial Meeting on Science, October 1963. Edited with an introduction and notes by Emmanuel G. Mesthene, Secretary of the Ministerial Meeting on Science. Paris: OECD, 1965, 178. (Note especially article by Jean-Jacques Salomon, "International Scientific Organizations," 57-87.)

250. ________. The OECD at Work. Paris: OECD, 1964, 148.

251. ________. Science and the Policies of Governments: The Implications of Science and Technology for National and International Affairs. Paris: OECD, 1963, 55.

252. Polach, Jaroslav G. EURATOM: Its Background, Issues, and Economic Implications. Dobbs Ferry, New York: Oceana, 1964, 232.

253. Rabinowitch, Eugene and Richard S. Lewis, eds. Man on the Moon: The Impact on Science, Technology, and International Cooperation. New York: Basic Books, 1969, 204.

254. Renborg, Bertil A. International Drug Control--A Study of International Administration by and through the League of Nations. Washington, D.C.: Carnegie Endowment for International Peace, 1947, 276.

255. Russell, Bertrand. Common Sense and Nuclear Warfare. New York; Simon and Schuster, 1959, 92.

256. Schwartz, Leonard E. International Organizations and Space Cooperation. Durham, North Carolina: World Rule of Law Center, 1962, 108.

257. Singh, Nagendra. Nuclear Weapons and International Law. New York: Praeger, 1959, 267.

258. Skolnikoff, Eugene B. Science, Technology, and American Foreign Policy. Cambridge, Massachusetts: M.I.T. Press, 1969, 330.

259. Small, George L. The Blue Whale. London: Columbia University Press, 1971, 248.

260. Sullivan, Walter. Assault on the Unknown: The International Geophysical Year. New York: McGraw-Hill, 460.

261. Twentieth Century Fund Task Force on International Satellite Communications. Communicating by Satellite. New York: Twentieth Century Fund, 1969, 79.

262. ________. The Future of Satellite Communications, Resource Management and the Needs of Nations. New York: Twentieth Century Fund, 1971, 27.

263. United Nations. "Convention on the High Seas, Geneva, 29 April 1958," in United Nations Treaty Series, CDL, Number 6465, New York: United Nations, 1963, 156.

264. ________. Papers Presented at the International Technical Conference on the Conservation of the Living Resources of the Sea: Rome, 18 April to 10 May, 1955. New York: United Nations, 1956, 371. (Note especially papers by Remington Kellogg, "The International Whaling Commission," 256-261; M.J. Girard, "Note on the General Fisheries Council for the Mediterranean," 262-266.)

265. United Nations. Pollution of the Sea by Oil: Results of an Inquiry Made by the United Nations Secretariat. New York: United Nations, 1956, 235.

266. ________. Advisory Committee on the Application of Science and Technology to Development. International Action to Avert the Impending Protein Crisis: Feeding the Expanding World Population. New York: United Nations, 1968, 106.

267. United Nations Educational, Scientific, and Cultural Organization. Bilateral Institutional Links in Science and Technology. Paris: UNESCO, 1969, 98.

268. ________. Communication in the Space Age: The Use of Satellites by the Mass Media. Paris: UNESCO, 1968, 200.

269. ________. Intergovernmental Conference of Experts on the Scientific Basis For Rational Use and Conservation of the Resources of the Biosphere: Final Report, Paris, 4-13 September 1968. Paris: UNESCO, 1968, 71.

270. ________. Main Trends of Research in the Social and Human Sciences: Part I, Social Sciences. Paris: UNESCO, 1970, 820.

271. ________. Manual for Surveying National Scientific and Technological Potential. New York: UNESCO, 1970, 251.

272. ________. UNESCO Handbook of International Exchanges. Paris: UNESCO, 1967, 1102.

273. United Nations Educational, Scientific, and Cultural Organization and the International Council of Scientific Unions. UNISIST--Synopsis of the Feasibility of a World Science Information System. Paris: UNESCO, 1971, 92.

274. United Nations Industrial Development Organization. WAITRO--World Association of Industrial and Technological Research Organizations. Report of the founding meeting held in Vienna, 28-30 October 1970. Vienna, Austria: UNIDO, 1971, 54.

275. U.S. Congress. International Environmental Science. Proceedings of the Joint Colloquium before the Committee on Commerce, U.S. Senate, and the Committee on Science and Astronautics, U.S. House of Representatives, 92nd Congress, 1st Session, May 25-26, 1971. Washington, D.C.: U.S. Government Printing Office, 1971, 241.

276. U.S. Congress. House. Committee on Foreign Affairs. Deficiencies in the Management and Delivery of U.N. Technical and Pre-Investment Assistance. Report of a Staff Survey Team of the Committee to the 92nd Congress, 1st Session, March 25, 1971. Washington, D.C.: U.S. Government Printing Office, 1971, 50.

277. ________. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. Foreign Policy Implications of Satellite Communications. Hearings before the Subcommittee to the 91st Congress, 2nd Session, April 23, 28, and 30, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 212.

278. ________. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. Satellite Broadcasting, Implications for Foreign Policy. Hearings before the Subcommittee to the 91st Congress, 1st Session, May 13-22, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 317.

279. ________. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. Science, Technology, and American Diplomacy: The Evolution of International Technology. Prepared for the Subcommittee by Franklin P. Huddle, Science Policy Research and Foreign Affairs Division, Legislative Reference Service, Library of Congress, 91st Congress, 2nd Session, December, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 70.

280. ________. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. Science, Technology, and American Diplomacy: Exploiting Resources of the Seabed. Prepared for the Subcommittee by George A. Doumani, Science Policy Research Division, Congressional Research Service, Library of Congress, 92nd Congress, 1st Session, July, 1971. Washington, D.C.: U.S. Government Printing Office, 1971, 152.

281. ________. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. Science, Technology, and American Diplomacy: The Politics of Global Health. Prepared for the Subcommittee by Freeman H. Quimby, Science Policy Research Division, Congressional Research Service, Library of Congress, 92nd Congress, 1st Session, May, 1971. Washington, D.C.: U.S. Government Printing Office, 1971, 79.

282. U.S. Congress. House. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. Science, Technology, and American Diplomacy: A Selected, Annotated Bibliography of Articles, Books, Documents, Periodicals, and Reference Guides. Prepared for the Subcommittee by Genevieve Knezo, Science Policy Research and Foreign Affairs Division, Legislative Reference Service, Library of Congress, 91st Congress, 2nd Session, March, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 69.

283. ________. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. Science, Technology, and American Diplomacy: Toward a New Diplomacy in a Scientific Age. Prepared for the Subcommittee by Franklin P. Huddle, Science Policy Research and Foreign Affairs Division, Legislative Reference Service, Library of Congress, 91st Congress, 2nd Session, April, 1970. Washington, D.C.: U.S. Government Prin.ing Office, 1970, 28.

284. ________. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. Symposium on Science and Foreign Policy: The Green Revolution. Hearings before the Subcommittee to the 91st Congress, 1st Session, December 5, 1969. Washington, D.C.: U.S. Government Printing Office, 1970, 238.

285. ________. Committee on Foreign Affairs. Subcommittee on International Organizations and Movements. U.S. Participation in 1972 United Nations Conference on Human Environment. Hearing before the Subcommittee on House Resolution 523 and House Resolution 562 to the 91st Congress, 1st Session, November 13, 1969. Washington, D.C.: U.S. Government Printing Office, 1970, 13.

286. ________. Committee on Science and Astronautics. International Science Policy. A Compilation of Papers Prepared for the 12th Meeting of the Panel on Science and Technology, 92nd Congress, 1st Session, February, 1971. Washington, D.C.: U.S. Government Printing Office, 1971, 166.

287. ________. Committee on Science and Astronautics. International Science Policy. Panel on Science and Technology, Twelfth Meeting, Proceedings before the Committee to the 92nd Congress, 1st Session, January 26-28, 1971. Washington, D.C.: U.S. Government Printing Office, 1971, 373.

288. U.S. Congress. House. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. House Joint Resolution 589, International Biological Program. Hearings before the Subcommittee to the 91st Congress, 1st Session, May 6-7, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 193.

289. ________. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Participation of Federal Agencies in International Scientific Programs. Prepared for the Subcommittee by Freeman H. Quimby, Science Policy Research and Foreign Affairs Division, Legislative Reference Serivce, Library of Congress, 90th Congress, 1st Session, 1967. Washington, D.C.: U.S. Government Printing Office, 1967, 167.

290. U.S. Congress. Senate. Two Conventions and Amendments Relating to Pollution of Sea by Oil. Message from the President of the United States transmitting two conventions done in Brussels at the International Legal Conference on Marine Pollution Damage, 1969; 91st Congress, 2nd Session, May 20, 1970. Senate Executive Document G. Washington, D.C.: U.S. Government Printing Office, 1970, 50.

291. ________. Committee on Commerce. Special Study on United Nations Suboceanic Lands Policy. Hearings before the Committee to the 91st Congress, 1st Session, September 23, 24, October 3, and November 21, 1969. Washington, D.C.: U.S. Government Printing Office, 1970, 186.

292. U.S. Department of State. The United States-Japan Committee on Scientific Cooperation. Department of State Publication 8210, East Asian and Pacific Series 158, International Scientific and Technological Affairs. Washington, D.C.: U.S. Government Printing Office, 1967, 70.

293. U.S. Library of Congress. Reference Department. General Reference and Bibliography Division. International Scientific Organizations: A Guide to Their Library Documentation, and Information Services. Washington, D.C.: U.S. Government Printing Office, 1962, 794.

294. United States Treaty Series 981. "Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere," in Treaties and Other International Agreements of the United States of America, 1776-1949, Volume III. Compiled under the direction of Charles I. Bevans. Washington, D.C.: U.S. Department of State, 1969, 630-660.

295. Vahle, C. W., Jr. Planning and Coordinating Oceanographic Programs. Washington, D.C.: Operations and Policy Research, April 17, 1969, 55. (Publications Board 182 602)

296. Vaughan, Thomas W., et al. International Aspects of Oceanography. Washington, D.C.: National Science Foundation, 1957, 225.

297. Walsh, Warren B. Science and International Public Affairs: Six Experiments in International Scientific Cooperation. Syracuse, New York: International Relations Program, Maxwell School, Syracuse University, 1967, 161.

298. Waters, Maurice, ed. The United Nations: International Organization and Administration. New York: Macmillan, 1967, 583.

299. Wilson, T.W., Jr. International Environmental Action: A Global Survey. New York: Dunellen, 1971, 364.

300. World Health Organization. The First Ten Years of the World Health Organization. Geneva: WHO, 1958, 538.

301. ________. National Environmental Health Programmes: Their Planning, Organization, and Administration. Report of a WHO Expert Committee. Geneva: WHO, 1970, 56.

302. World Wildlife Fund. All Life on Earth. Second International Congress of the World Wildlife Fund, London, November 17-18, 1970. Morges, Switzerland: World Wildlife Fund, 1970, 116.

303. ________. World Wildlife Yearbook 1970-71, ed. by Peter Jackson. Morges, Switzerland: World Wildlife Fund, 1971, 300.

304. Yates, Lamartine. So Bold an Aim: Ten Years of International Cooperation toward Freedom from Want. Rome: Food and Agriculture Organization, 1955, 174.

305. Yearbook of International Organizations. Tenth Edition, 1964-65. Brussels: Union of International Organizations, 1965. (Note Part IV, Chapter 14, pp. 1123-1215.)

Addendum:

306. Caldwell, Lynton K. In Defense of Earth: International Protection of the Biosphere. Bloomington: Indiana University Press, 1972, 295.

307. de Seynes, Philippe. "The United Nations Committee on Natural Resources and Its Challenge," Technological Forecasting and Social Change, III (Number 2, 1972), 155-158.

308. Falk, Richard A. This Endangered Planet: Prospects and Proposals for Human Survival. New York: Random House, 1971, 495.

309. International Institute for Environmental Affairs. The Human Environment: Science and International Decision-Making. New York: International Institute for Environmental Affairs, 1971, 31.

310. National Academy of Sciences. National Academy of Engineering. Environmental Studies Board. Institutional Arrangements for International Environmental Cooperation: A Report to the Department of State by the Committee for International Environmental Programs. Washington, D.C.: National Academy of Sciences, 1972, 74.

311. U.S. Congress. Senate. Committee on Commerce. 1972 Survey of Environmental Activities of International Organizations. Prepared by the Committee, with the assistance of Harvey R. Sherman and Howard A. Brown, Environmental Policy Division, Congressional Research Service, Library of Congress, 92nd Congress, 2nd Session, February, 1972, 187.

LEADING QUESTIONS

1. What are the principal categories into which international organizations for science and technology are customarily grouped? What are the principal criteria for their classification?

2. To what extent does the United Nations function as an international organization for science and technology?

3. What have been the principal contributions of UNESCO to the advancement of science and technology, and how have its scientific activities been organized?

4. What are the prospects for international scientific and technological organizations acquiring an identity independent of the system of national states? Is there a significance in the term "World," in the name of several organizations? What problems or dangers or advantages might result from a world scientific organization that was independent of national governments?

5. What has been the role of nongovernmental professional associations in the international organization of science and technology? What have been the contributions of these associations?

6. In view of the generally high prestige of science and scientists, what accounts for the relatively low priority accorded international scientific cooperation by many governments? What aspects of international cooperation are most widely resisted and why?

7. In what matters is international scientific cooperation most urgently needed today? What are the principal barriers to this cooperation?

8. What specific measures might be taken to strengthen international scientific cooperation? What forms of cooperation appear to have worked most effectively thus far?

9. What has been the contribution of international scientific conferences and seminars to international cooperation? Are gatherings like the Pugwash Meetings significant?

10. What are the implications for international relations in the highly differential rate of scientific and technological development in the "advanced" and newly emerging nations? Is technoscientific "imperialism" a possible consequence of the inability of underdeveloped countries to cope with science-induced problems and the necessity for recourse to technical assistance from more "advanced" societies?

TOPIC 10 TECHNOSCIENCE IN THE DEVELOPING COUNTRIES

Modern science had its genesis in Western Europe in an historical period coincident with the rise of nationalism and the expansion of European political control to nearly all parts of the world. The science brought from Europe to the non-European world was not only an alien force, but was also an aspect of an alien and threatening civilization. In a few cases--most notably in Japan--science was seen as separable from other aspects of Western civilization. Japan became a modern scientific and technological power while retaining many of the values and characteristics of its traditional civilization.

As many former dependencies gained national status after World War II, efforts were made through international technical assistance to develop science and technology in these new nations. Participating in this assistance were the United Nations and their affiliated organizations; multilateral groups such as the Organization for Economic Cooperation and Development, the North Atlantic Treaty Organization, and the American Alliance for Progress; and bilateral arrangements of which the so-called foreign aid program of the United States was the principal example. In 1963, the United Nations sponsored at Geneva a Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, with 96 governments represented. The efforts that have gone into developing scientific competence in the new nations have been impressive. Unfortunately, the results have frequently been disappointing.

A basic reason for the slowness of the scientific way of life to take root in the non-Western world is perhaps because science itself has been an aspect of Western culture. Unless, as in Japan, science found an accommodating conjunction of values, it could not establish itself. During the nineteen sixties, there was a rapid development of technological capability in the People's Republic of China, but the status of science in China has been difficult to assess. Science in the Western world has been the outgrowth of at least three centuries of cultural change. It is not surprising that most new nations have found it difficult to make this transition in a single generation. Moreover, it should also be remembered that science is not as yet a major interest or influence in the lives of large numbers of people even in the most technoscientifically advanced countries.

A secondary factor in retarding the growth of science in the new nations has been the bias of the aid-giving powers toward economic as the prime mover of societies. A widely prevailing assumption of international technical assistance has been that if national economies can be activated to reach some specified "take-off" point, development of the more advanced aspects of the technoscientific culture automatically will follow. Unfortunately, economic planning as it has been applied in most of the new and developing nations does not appear to have enabled them to generally improve the quality of life for their peoples or to have protected or improved the viability of their biophysical environments. Specific successes have been achieved, but the technoscientific superculture through which the future state of the world may be determined is still overwhelmingly concentrated in the nations which gave it birth.

TOPIC 10 TECHNOSCIENCE IN THE DEVELOPING COUNTRIES

Selected Basic Readings:

Boffey, Philip M. "Japan (I): On the Threshold of an Age of Big Science," Science, CLXVII (January 2, 1970), 31-35; "Japan (II): University Turmoil Is Reflected in Research," Ibid. (January 9, 1970), 147-152; "Japan (III): Industrial Research Struggles to Close the Gap," Ibid. (January 16, 1970), 264-267.

Borlaug, Norman E. "The Green Revolution: For Bread and Peace," Bulletin of the Atomic Scientists, XXVII (June, 1971), 6-9; 42-48.

Brown, H. "Science, Technology and the Developing Countries," Bulletin of the Atomic Scientists, XXVII (June, 1971), 10-14.

Moravcsik, Michael V. "Some Modest Proposals," Minerva, IX (January, 1971), 55-65.

Signer, Ethan and Arthur W. Galston. "Education and Science in China," Science, CLXXV (January 7, 1972), 15-23.

Supplementary and Substitute Readings:

Baldwin, George B. "Brain Drain or Overflow," Foreign Affairs, XLVIII (January, 1970), 358-372.

Blackett, P. M. S. "Science and Technology in an Unequal World," Science and Culture, XXIV (January, 1968), 16-24.

Dessau, Jan. "Social Factors Affecting Science and Technology in Asia," Impact of Science on Society, XIX (January-March, 1969), 13-23.

Mboya, Thomas J. "Technology in the Development of Africa: A Critique," Impact of Science on Society, XIX (October-December, 1969), 331-338.

Minerva. "Science in Underdeveloped Countries: World Plan of Action for the Application of Science and Technology to Development," Minerva, IX (January, 1971), 101-121.

Paddock, William C. "How Green Is the Green Revolution?" AIBS Bulletin (BioScience), XX (August 15, 1970), 897-902.

TOPICAL OUTLINE	REFERENCE KEY
1. Influence of Science and Technology upon the Processes of National Development--Cultural, Economic, and Political	6, 69, 98, 107, 108, 124, 150, 159
A. Science and technological innovation as acculturating forces	146
1. In Western society (cf. Topics 02 and 03)	
2. In non-Western traditional societies	47, 116
B. Expansion of Western societies under the impetus of technological development	
1. Colonialism as an adjunct of technological development	170
a. Mercantilist systems	
b. Raw materials and markets in industrial economies	135, 144
c. Exporting unemployment	104
2. The white man's burden--the cultural mission of the West	115
a. Religious missions as vectors of Western industry and science	
b. The cultural role of international business	
c. The cultural mission of education: foundations, universities, international technical assistance	
C. Primacy of political economy over science in the development process	26, 49, 53, 79
1. The domination of economic theory in the West	112
a. Capitalism and its modifications reflecting an economic perspective on society	
b. Marxism as a Western heresy--the primacy of politics over economics in an ideology of economic determinism	210, 223

2. Conflicting interpretations of the relationship of science and technology to the development process--an aspect of conflict between Western ideologies in the new and "underdeveloped" nations	69, 73, 97, 181
3. Resistance to "the scientific culture" in traditional societies	44, 80, 116
a. Identification of science with Western influence	170, 253
b. Religious and traditional rejection of science in authoritarian political systems	51
c. Marxist rejection of scientific objectivity in areas dominated by political ideology (cf. Topic 07)	221
D. Adaptation of traditional society to science	
1. The emergence of Japan as a techno-scientific ~~state~~	250 through 276
2. Science and technology in mainland China	182 through 223
II. Extension of the Benefits of Science and Technology to the New Nations--International Technical Assistance (See also Topic 09)	28, 33, 39, 68, 69, 73, 79, 80, 123, 139, 145
A. United Nations technical assistance	89, 146
1. The U.N. expanded program	46
2. Work of the affiliated agencies	
a. UNESCO	177, 313
b. WHO	4
c. FAO	
d. IAEA	
3. The Geneva Conference of 1963	126, 146, 158, 159
B. United States technical assistance programs	22, 25, 30, 33, 59, 68, 84, 90, 126, 128, 134, 157, 158
C. Technical assistance by European and advanced Asian states--e.g., Israel and Japan	118, 137

D. Technical assistance by the Soviet-East European bloc — 33, 161

III. "Development" as a Vehicle for the Transfer and Application of Science and Technology — 1, 8, 10, 26, 64, 85, 99, 101, 102, 103, 110, 124, 125, 134, 138, 143, 145, 146, 149

A. Meanings and assumptions of the development concept — 14, 36, 69, 91, 109, 122, 129

1. Emphasis heavily economic — 6, 9, 12, 51, 53, 76, 100, 112, 127, 153, 176
2. "Modernization" as a socio-political goal of development — 92, 135, 143
3. Neglect of cultural and ecological values — 6, 52, 109, 115, 116, 150
4. Critics of economic development — 52

B. Limited Influence of Science [illegible] Development — 55, 151

1. What is transferred is not "science", but rather the expertise of particular specialists in particular sciences and technologies — 54, 73, 97
2. Development decisions often politically inspired are not receptive to "scientific" reservations — 114
3. Relatively few people in developing countries capable of making critical assessment of their own needs and options — 65, 106, 142, 148, 152
4. Motivations in aid-giving countries mixed; science seldom a dominant factor — 33, 39, 67

IV. Problems of Developing Science and Technology in the New Nations	6, 13, 37, 40, 54, 55, 63, 64, 67, 69, 71, 72, 103, 106, 125, 130, 302
A. Cultural orientation	118, 140
1. Political acceptance of freedom of inquiry and of critical appraisal of technology often absent	35
2. Need for social recognition of scientific and technical work and training as "high status" and attractive to the educated youth	97
3. Lack of local opportunity results in a "brain drain" to industrialized nations	5, 23, 56, 7[illegible], 81, 87, 84, 96, 104, 113, 120, 279
B. Environmental problems	31, 51
1. Inadequate criteria for establishing priorities in development	18, 38, 40, 70, 98, 114, 148
2. Traumatic effect of a leap from tribalism to urbanism--the case of Central Africa	122, 159, 171
3. Narrowing margin of opportunity resulting from abuse or destruction of natural environments and resources	24
4. National rivalry and ambition as handicaps to international cooperation on environmental issues	21, 88
a. International rivers	159
b. Wildlife and natural areas	24
c. Population policy	22, 75, 78, 132, 155, 156
5. Growing awareness of environmental hazards in the developing countries	51, 52
C. Institutional support	66, 71, 83, 85
1. The educational base for science and technology--transferred curricula and teaching methods often inappropriate	11, 15, 29, 48, 137

2. Higher education, the development of scientists, engineers, and biomedical professionals	14, 29, 60, 102, 228, 245
3. Limited availability of funds for supporting scientific research	2, 40, 61, 85, 87
4. The role of government in the advancement and control of science and technology usually nonexistent, uncertain, or opportunistic	11, 63, 72, 86
5. Need for external reinforcement from politically acceptable source, e.g., international rather than bilateral assistance	25, 28

BIBLIOGRAPHY

General References: Articles

1. Allen, Thomas J. and S. Cooney. "The International Technological Gatekeeper," Technology Review, LXXIII (March, 1971), 37-43.

2. Anderson, R. S. "Are Conferences on Science in Poor Nations a Useless Extravagance?" Science Forum, IV (December, 1971), 12-15.

3. Apter, David E. "New Nations and the Scientific Revolution," Bulletin of the Atomic Scientists, XVII (February, 1961), 60-64.

4. Ascher, Charles S. "Current Problems in World Health Organization's Program," International Organizations, VI (Winter, 1952), 27-50.

5. Baldwin, George B. "Brain Drain or Overflow," Foreign Affairs, XLVIII (January, 1970), 358-372.

6. Baranson, Jack. "Economic and Social Considerations in Adapting Technologies for Developing Countries," Technology and Culture, IV (Winter, 1963), 22-29.

7. ________. "National Programs for Science and Technology in the Underdeveloped Areas," Bulletin of the Atomic Scientists, XVI (May, 1960), 151-154.

8. ________. "New Technologies for Developing Areas," Bulletin of the Atomic Scientists, XVII (September, 1961), 275-277.

9. Barnea, J. "Economic Implications of Electrification in Under-Developed Countries," Economic Development and Cultural Change, II (June, 1954), 371-379.

10. Bar-Zakay, S. N. "Policymaking and Technology Transfer: The Need for National Thinking Laboratories," Policy Sciences, II (Summer, 1971), 213-227.

11. Bergmann, E. D. "Technical Strength for a New Nation," Science and Technology, Number 72 (December, 1967), 62-69.

12. Beringer, C. "Aid for Research in Agricultural Development," OECD Observer, Number 32 (February, 1968), 12-15.

13. Bhabha, H. S. "Science and the Problems of Development," Science, CLI (February 4, 1966), 541-548.

14. Bhathal, R. S. "Science Policy in the Developing Nations," Nature, CCXXXII (July 23, 1971), 227-229.

15. Black, Max. "A Lend-Lease Program for Philosophy and Science," Scientific Monthly, LXI (September, 1945), 165-172.

16. Blackett, P. M. S. "The Ever Widening Gap," Science, CLV (February 24, 1967), 959-964.

17. ________. "New Science in Old Technology," Bulletin of the Atomic Scientists, XVII (February, 1961), 53-54.

18. ________. "Planning for Science and Technology in Emerging Countries," New Scientist, XVII (February 14, 1963), 345-346.

19. ________. "Role of the Technologist in the Modern World," Nature, CCXII (December 3, 1966), 975.

20. ________. "Science and Technology in an Unequal World," Science and Culture, XXXIV (January, 1968), 16-24.

21. Blount, B. K. "Science Will Change the Balance of Power," New Scientist, II (June 27, 1957), 8-9.

22. Borlaug, Norman E. "The Green Revolution: For Bread and Peace," Bulletin of the Atomic Scientists, XXVII (June, 1971), 6-9, 42-48.

23. Bowden, Lord. "The Migrant Scientist," New Scientist, XXI (March 5, 1964), 594-596.

24. Brenan, J. P. M. "The Value of Flora to Underdeveloped Countries," Impact of Science on Society, XII (Number 2, 1963), 121-146.

25. Brown, Harrison S. "Science, Technology, and the Developing Countries," Bulletin of the Atomic Scientists, XXVII (June, 1971), 10-14.

26. ________. "Science, Technology, and World Development," Bulletin of the Atomic Scientists, XIV (December, 1958), 409-412.

27. Brown, Roy E. "Medical Problems of the Developing Countries," Science, CLIII (July 15, 1966), 271-275.

28. Buzzati-Traverso, Adriano A. "Scientific Research: The Case for International Support," Science, CXLVIII (June 11, 1965), 1440-1444.

29. Caine, Sydney. "Education for Development," Advancement of Science, XIV (December, 1957), 191-200.

30. Calder, Nigel. "Space Techniques for Poor Countries," New Scientist, XXXIX (August 29, 1968), 445-446.

31. Carpenter, Francis W. "Conservation of World Resources: A Report on U.N. Scientific Conference," Bulletin of the Atomic Scientists, V (November, 1949), 313-314.

32. Carter, Luther J. "Project BOMEX: Biggest Weather Study Yet," Science, CLXIII (March 28, 1969), 1435-1436.

33. Cohen, Benjamin I. "U.S.-U.S.S.R. in Developing Countries," Bulletin of the Atomic Scientists, XXVIII (February, 1972), 22-28.

34. Dedijer, Stevan. "The Birth and Death of a Myth," Bulletin of the Atomic Scientists, XIV (May, 1958), 164-168.

35. ________. "Research and Freedom in Underdeveloped Countries," Bulletin of the Atomic Scientists, XIII (September, 1957), 238-242.

36. ________. "Research: The Motor of Progress," Bulletin of the Atomic Scientists, XVIII (June, 1962), 4-7.

37. ________. "Underdeveloped Science in Underdeveloped Countries," Minerva, II (Autumn, 1963), 61-81.

38. Deutch, Michael J. "Can We Afford Atomic Power for Underdeveloped Countries?" Bulletin of the Atomic Scientists, XVI (January, 1960), 23-27.

39. Dickson, Alec. "Technical Assistance and Idealism; Misgivings and Mistakings," Advancement of Science, XIV (December, 1957), 177-182.

40. Djerassi, Carl. "A High Priority? Research Centers in Developing Nations," Bulletin of the Atomic Scientists, XXIV (January, 1968), 22-27.

41. Drucker, Peter F. "Modern Technology and Ancient Jobs," Technology and Culture, IV (Summer, 1963), 277-281.

42. Eban, Abba. "Science and the New States," Bulletin of the Atomic Scientists, XVI (February, 1961), 57-60.

43. Freeman, C. "Research Comparisons," Science, CLVIII (October 27, 1967), 463-468.

44. Friedland, William H. "Traditionalism and Modernization: Movements and Ideologies," Journal of Social Issues, XXIV (October, 1968), 9-23.

45. Frontard, R. "Standardization in Developing Countries," Impact of Science on Society, XII (Number 4, 1962), 279-300.

46. Gibboney, Carl N. "The United Nations Scientific Conference for the Conservation and Utilization of Resources," Science, CX (December 23, 1949), 675-678.

47. Goldschmidt, Arthur. "Technology in Emerging Countries," Technology and Culture, III (Fall, 1962), 581-600.

48. Grayson, Lawrence P. "Education beyond the Horizon," Science, CLXX (December 25, 1970), 1376-1382.

49. Gutierrez-Olivos, Sergio. "Science, Foreign Relations, and Government in Developing Nations," Nature, CCIV (December 5, 1964), 916-918.

50. Hemptinne, Yvan de. "The Science Policy of States in Course of Independent Development," Impact of Science on Society, XIII (Number 3, 1963), 233-247.

51. Henkin, Harmon. "Side-Effects," Environment, XI (January-February, 1969), 28-35, 48.

52. Heyneman, D. "Why We Must Prevent Foreign Aid from Becoming an Ecological Nightmare," Science Forum, IV (October, 1971), 3-9.

53. Hirschman, Albert O. and Charles E. Lindblom. "Economic Development, Research and Development, Policy-Making: Some Converging Views," Behavioral Science, VII (April, 1962), 211-222.

54. Hoselitz, Bert F. "Problems of Adapting and Communicating Modern Techniques to Less Developed Areas," Economic Development and Cultural Change, II (January, 1954), 268-299.

55. Kabir, S. "Science Fails in the Third World," New Scientist, XLVI (April 2, 1970), 15-16.

56. Kannappan, S. "The Brain Drain and Developing Countries," International Labor Review, XCVIII (July, 1968), 1-26.

57. Keyfitz, Nathan. "Population Density and the Style of Social Life," AIBS Bulletin (BioScience), XVI (December, 1966), 868-873.

58. Kovda, Victor A. "Index of Prosperity: S.T.P.," UNESCO Courier, XVI (July-August, 1963), 19-23.

59. Lee, Gordon C. "The University--USAID Relationship," Public Administration Review, XXIX (May-June, 1969), 276-285.

60. Lewis, W. Arthur. "Education for Scientific Professions in Poor Countries," Daedalus, XCI (Spring, 1962), 310-318.

61. ________. "Needs of the New States--Science, Man, and Money," Bulletin of the Atomic Scientists, XVII (February, 1961), 43-47.

62. Lindbeck, J. M. "An Isolationist Science Policy," Bulletin of the Atomic Scientists, XXV (February, 1969), 66-72.

63. Lonsdale, D. K. "Developing Nations and Scientific Responsibility," Bulletin of the Atomic Scientists, XXV (November, 1969), 27-28.

64. Lopes, J. Leite. "Science for Man: The Development Gap," Bulletin of the Atomic Scientists, XXIV (December, 1968), 14-17.

65. Low, Ian. "Research Targets for a Better World," New Scientists, XXVII (July 1, 1965), 18-19.

66. Malecki, I. "Some Problems Concerning Organization of Scientific Research in the Developing Countries," Impact of Science on Society, XIII (Number 3, 1963), 181-200.

67. Margolis, Howard. "New Research Programs: Help for Underdeveloped Nations...and for Underdeveloped Industry at Home," Science, CXXXVI (June 1, 1962), 765.

68. Martin, Roscoe C. "Technical Assistance: The Problem of Implementation," Public Administration Review, XII (Autumn, 1952), 258-266.

69. Minerva. "Science in Underdeveloped Countries: World Plan of Action for the Application of Science and Technology to Development," Minerva, IX (January, 1971), 101-121.

70. Miller, David. "Atoms in Asia," Nuclear News, X (May, 1967), 21-26.

71. Moravcsik, Michael V. "Some Modest Proposals," Minerva, IX (January, 1971), 55-65.

72. ________. "Some Practical Suggestions for the Improvement of Science in Developing Countries," in Criteria for Scientific Development: Public Policy and National Goals, ed. by Edward Shils. Cambridge, Massachusetts: M.I.T. Press, 1968, 207.

73. ________. "Technical Assistance and Fundamental Research in Underdeveloped Countries," Minerva, II (Winter, 1964), 197-209.

74. Murcier, A. "Brains for Sale," Bulletin of the Atomic Scientists, XXIV (March, 1968), 38-46.

75. Myrdal, Gunnar. "Population and Resources," Ceres, III (January-February, 1970), 51-61.

76. OECD Observer. "Relating Science and Technology to Economic Development: A Five-Country Experiment," OECD Observer, Number 15 (April, 1965), 8-11.

77. Osbourne, Denis. "The Use and Promotion of Science in Developing Countries," Minerva, IX (January, 1971), 45-55.

78. Paddock, William C. "How Green Is the Green Revolution?" AIBS Bulletin (BioScience), XX (August 15, 1970), 897-902.

79. Parsons, Ernest. "Programming Technical Assistance for Developing Countries," OECD Observer, Number 17 (August, 1965), 37-39.

80. Parthasarathi, Ashok. "'Aid' Science: Help or Hindrance?" New Scientist, XXXII (December 15, 1966), 642-643.

81. ________. "Brain Drain from Developing Countries," Nature, CCXXX (March 12, 1971), 87-90.

82. Paulian, R. "Science in the Service of Man in the Tropical Regions," Impact of Science on Society, X (Number 4, 1960), 230-242.

83. Quinn, James B. "National Strategy in Science and Technology," Science Journal, V (April, 1969), 77-81.

84. Raushenbush, Stephen. "Point Four," Scientific American, CLXXXII (March, 1950), 16-19.

85. Ray, K. "Research in the Third World," New Scientist, XLII (May 22, 1969), 420-421.

86. Rizos, E. J. "Science and Technology in Country Development: Towards an Understanding of the Role of Public Administration," International Review of Administrative Sciences, XXXII (Number 4, 1966), 335-345.

87. Sabato, J. A. "Quantity versus Quality in Scientific Research (I): The Special Case of Developing Countries," Impact of Science on Society, XX (July-September, 1970), 183-193.

88. Sachs, Gnacy. "Development Planning and Environment: The Case of Countries of the Third World," Social Science Information, IX (October, 1970), 2-27.

89. Sai, F. T. "The Health and Nutrition of the Less Developed Areas," Impact of Science on Society, XIII (Number 3, 1963), 213-232.

90. Scientific Research. "IDA and the Universities: What Next?" Scientific Research, III (January 8, 1968), 23-27.

91. Shils, Edward. "Scientific Development in the New States," Bulletin of the Atomic Scientists, XVII (February, 1961), 48-52.

92. Tannous, Afif I. "Positive Role of the Social Scientist in the Point Four Program," Scientific Monthly, LXXII (January, 1951), 42-49.

93. Thacker, M. S. "The Dedication Decade," Impact of Science on Society, XIII (Number 3, 1963), 175-180.

94. Thiesenhusen, W. C. "Building New Nations: Compensation for the Brain Drain," Current, XCVI (June, 1968), 48-52.

95. Trombe, Felix. "Some Aspects of the Uses of Natural Radiation, Especially in the Developing Countries," Impact of Science on Society, XV (Number 4, 1965), 247-260.

96. Turnham, D. "The Employment Problem in Less Developed Countries," OECD Observer, Number 49 (December, 1970), 6-10.

97. Varsavsky, O. "Scientific Colonialism in the Hard Sciences," American Behavioral Scientist, X (June, 1967), 22-23.

98. White, Stanley. "Status Symbol or Stimulus?" New Scientist, XXX (May 26, 1966), 542-543.

99. Wu, Chi-Yuen. "Operational Research for Developing Countries," International Review of Administrative Sciences, XXXVI (Number 2, 1970), 99-108.

100. Yudelman, M. "The Green Revolution," OECD Observer, Number 52 (June, 1971), 15-18, 27-30.

101. Zaheer, S. H. "The Development of Science and Technology in Underdeveloped Countries," Scientific World, XII (June, 1968), 9-12.

102. Ziman, John M. "Growth and Spread of Science," Nature, CCXXI (February 8, 1969), 521-524.

103. ________. "Three Patterns of Research in Developing Countries," Minerva, IX (January, 1971), 32-37.

General References: Books

104. Adams, W., ed. The Brain Drain. New York: Macmillan, 1968, 273.

105. Aron, Raymond, ed. World Technology and Human Destiny. Ann Arbor: University of Michigan Press, 1963, xi, 249.

106. Asher, Robert E., et al. Development of the Emerging Countries: An Agenda for Research. Washington, D.C.: Brookings Institution, 1962, 239.

107. Baranson, Jack. Industrial Technologies for Developing Economies. New York: Praeger, 1969, 186.

108. Baranson, Jack. Technology for Underdeveloped Areas: An Annotated Bibliography. New York: Pergamon, 1967, 81.

109. Brode, John. The Process of Modernization: An Annotated Bibliography on the Socio-Cultural Aspects of Development. Cambridge, Massachusetts: Harvard University Press, 1969, 378.

110. Brown, Lester R. Seeds of Change: The Green Revolution and Development in the 1970's. New York: Praeger, 1970, 205.

111. Bryant, John. Health and the Developing World. Ithaca, New York: Cornell University Press, 1969, 345.

112. Cambel, A. B., et al. Energy Research and Development and National Progress. Washington, D.C.: U.S. Government Printing Office, 1966, 437.

113. Committee on the International Migration of Talent. The International Migration of High-Level Manpower: Its Impact on the Development Process. New York: Praeger, 1970, 738.

114. Elek, Paul. The Arms Trade with the Third World. Stockholm: International Peace Research Institute, 1971, 910.

115. Erasmus, Charles J. Man Takes Control: Cultural Development and American Aid. Minneapolis: University of Minnesota Press, 1961, 365.

116. Foster, George M. Traditional Cultures and the Impact of Technological Change. New York: Harper and Row, 1962, 292.

117. Glaser, P. E., et al. Space Technology Transfer and Developing Nations. Prepared under contract NASw-1649. Cambridge, Massachusetts: Arthur D. Little, 1968, 153.

118. Gruber, Ruth, ed. Science and the New Nations: Proceedings of the International Conference on Science in the Advancement of New States at Rehovoth, Israel. New York: Basic Books, 1961, 314.

119. Haskins, Caryl P. The Scientific Revolution and World Politics. New York: Harper and Row, 1964, 115.

120. Henderson, G. Emigration of Highly Skilled Manpower from the Developing Countries. UNITAR Research Report No. 3. New York: United Nations Institute for Training and Research, 1970, 213.

121. Hill, A. V. The Ethical Dilemma of Science and Other Writings. New York: Rockefeller Institute Press, in Association with Oxford University Press, 1960, xiii, 395.

122. Hunter, Guy. Modernizing Peasant Societies: A Comparative Study in Asia and Africa. New York: Oxford University Press, 1969, 324.

123. Jackson, Robert G. A. The Case for an International Development Authority. Syracuse, New York: Syracuse University Press, 1957, 70.

124. Jackson, Willis. Technology and the Developing Countries. Bedford, England: Sidney Press, 1966, 23.

125. Jones, Graham. The Role of Science and Technology in Developing Countries. Published for the International Council of Scientific Unions. London and New York: Oxford University Press, 1971, 174.

126. Katz, Saul M. and Frank McGowan. A Selected List of U.S. Readings on Development. Prepared for the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas. Washington, D.C.: Agency for International Development, 1963, xvii, 363.

127. Meier, Richard L. Science and Economic Development: New Patterns of Living. Second Edition. Cambridge, Massachusetts: M.I.T. Press, 1960, xxi, 273.

128. Moseman, Albert H., ed. Agricultural Sciences for the Developing Nations. Washington, D.C.: American Association for the Advancement of Science, 1964, 221. Biblio.

129. Myrdal, Gunnar. Asian Drama: An Inquiry into the Poverty of Nations. New York: Twentieth Century Fund, 1968, xxx, 2284.

130. ________. The Challenge of World Poverty: A World Anti-Poverty Program in Outline. New York: Pantheon, 1970, xviii, 518.

131. Nader, Claire and A. B. Zahlan, eds. Science and Technology in Developing Countries. New York: Cambridge University Press, 1969, 588.

132. Nanes, A.S. Beyond Malthus: The Food/People Equation. Prepared for the Subcommittee on National Security Policy and Scientific Developments of the Committee on Foreign Affairs, U.S. House of Representatives. Washington, D.C.: U.S. Government Printing Office, 1971, 96.

133. Nasr, Seyyed H. Science and Civilization in Islam. Cambridge, Massachusetts: Harvard University Press, 1968, xiv, 384.

134. National Academy of Sciences. The International Development Institute. Report of an Ad Hoc Committee of the Board on Science and Technology for International Development. Washington, D.C.: National Academy of Sciences, 1971, 57.

135. National Academy of Sciences-National Research Council. Social and Economic Aspects of Natural Resources. By Gilbert F. White. Washington, D.C.: NAS-NRC, 1962, 53.

136. Netschert, B. C. and S. H. Schurr. Atomic Energy Applications with Reference to Underdeveloped Countries. Baltimore: Johns Hopkins Press, 1957, 129.

137. Organization for Economic Cooperation and Development. Aid to Education in Less Developed Countries. Paris: OECD, 1971, 270.

138. Pearson, Lester B. The Crisis of Development. New York: Praeger, 1970, 117.

139. ________. Partners in Development: Report of the Commission on International Development. New York: Praeger, 1969, 399.

140. Schram, Wilbur. Mass Media and National Development: The Role of Information in the Developing Countries. Stanford, California: Stanford University Press, 1965, 333.

141. Schultz, Theodore W. Transforming Traditional Agriculture. New Haven, Connecticut: Yale University Press, 1964, xiv, 212.

142. Shils, Edward, ed. Criteria for Scientific Development: Public Policy and National Goals. Cambridge, Massachusetts: M.I.T. Press, 1968, 207.

143. Silvert, Kalman H. The Social Reality of Scientific Myth: Science and Social Change. New York: American Universities Field Staff, 1969, 239.

144. Smith, Mervyn L., ed. Role of Science in the Development of Natural Resources, with Particular Reference to Iran, Turkey, and Pakistan. Oxford: Pergamon, 1964, 454.

145. Spencer, Daniel L. and Alexander Woroniak, eds. The Transfer of Technology to Developing Countries. New York: Praeger, 1967, 223.

146. United Nations. Science and Technology for Development: Report on the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas, eight volumes. New York: United Nations, 1963.

I. World of Opportunity. viii, 262.
II. Natural Resources. viii, 243.
III. Agriculture. viii, 309.
IV. Industry. viii, 265.
V. People and Living. viii, 217.
VI. Education and Training. viii, 197.
VII. Science and Planning. viii, 167.
VIII. Primary Proceedings, List of Papers, and Index. viii, 295.

147. ________. Space Science and Technology: Benefits to Developing Countries. New York: United Nations, 1968, 59.

148. ________. Advisory Committee on the Application of Science and Technology to Development. Natural Resources of Developing Countries: Investigation, Development, and Rational Utilization. New York: United Nations, 1970, 174.

149. United Nations Educational, Scientific, and Cultural Organization. The Application of Science and Technology to the Development of Asia. Final Report of the Conference at New Delhi (1968). Volume I: Conclusions and Recommendations. Paris: UNESCO, 1969, 36.

150. ________. Cultural Patterns and Technical Change, ed. by Margaret Mead. Paris: UNESCO, 1953, 348.

151. United Nations Educational, Scientific, and Cultural Organization. International Aspects of Technological Innovation. Proceedings of a Science Policy Symposium, Paris, France, September, 1970. Paris: UNESCO, 1971, 90.

152. ________. Manual for Surveying National Scientific and Technological Potential. Collection and Processing of Data. Management of the "R&D" System. Paris: UNESCO, 1970, 256.

153. ________. Role of Science and Technology in Economic Development. Paris: UNESCO, 1970, 216.

154. ________. World Directory of National Science Policy-Making Bodies. Volume II, Asia and Oceania. Paris: UNESCO, 1968, 157.

155. U.S. Congress. House. Committee on Appropriations. Subcommittee on Departments of Labor and Health, Education, and Welfare and Related Agencies. The Population Explosion and the Green Revolution. Hearings before the Subcommittee to the 92nd Congress, 1st Session, May 13, 1971. Washington, D.C.: U.S. Government Printing Office, 1971, 22.

156. ________. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. The Green Revolution, Symposium on Science and Foreign Policy. Proceedings before the Subcommittee to the 91st Congress, 1st Session, December 5, 1969. Washington, D.C.: U.S. Government Printing Office, 1970, 238.

157. U.S. International Development Agency. The AID Research Program: 1962-1971. Washington, D.C.: Agency for International Development, 1971.

158. ________. Report of the United States Delegation to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas. Geneva, Switzerland, February 4-20, 1963. Washington, D.C.: Agency for International Development, 1963, 335.

159. ________. Science, Technology, and Development: United States Papers Prepared for the United Nations Conference on the Application of Science and Technology for the Benefit of Less Developed Areas, twelve volumes. Washington, D.C.: U.S. Government Printing Office, 1963.

I. Natural Resources: Energy, Water, and River Basin Development. ix, 378.
II. Natural Resources: Minerals and Mining, Mapping, and Geodetic Control. vii, 355.
III. Agriculture. x, 262.
IV. Industrial Development. ix, 190.
V. Transportation. ix, 155.
VI. Health and Nutrition. vi, 196.
VII. Social Problems of Development and Urbanization. ix, 89.
VIII. Organization, Planning, and Programming for Economic Development. x, 144.
IX. Scientific and Technological Policy, Planning, and Organization. xi, 60.
X. International Cooperation and Problems of Transfer and Adaptation. viii, 63.
XI. Human Resources: Training of Scientific and Technological Personnel. xii, 204.
XII. Communications. viii, 162.

160. Weidner, Edward W. The World Role of Universities. New York: McGraw-Hill, 1962, x, 366.

161. Wilbur, Charles K. The Soviet Model and Underdeveloped Countries. Chapel Hill: University of North Carolina Press, 1969, 241.

Science in Selected Countries--Developing and Developed: Articles and Books

African States

162. Adiseshiah, M. S. "The Planned Development of Scientific Research in Africa," Impact of Science on Society, XIV (Number 3, 1964), 137-144.

163. Baldwin, K. D. S. The Nigerian Agricultural Project. Oxford: Blackwell, 1957.

164. Bassir, Olumbe. "Nigeria's Development Problem," New Scientist, LII (December 30, 1971), 265-266.

165. Bayh, Birch. "U.S. Policy toward Africa," Congressional Record, CXVII (October 5, 1971), S15826-S15829.

166. Cook, O. F. "Africa Needs Palms as Tree Crops," Scientific Monthly, LXII (February, 1945), 131-139.

167. Dumont, R. "Accelerating African Agricultural Development," Impact of Science on Society, XII (Number 4, 1962), 231-254.

168. Mboya, Thomas J. "Technology in the Development of Afric[illegible] tique," Impact of Science on Society, XIX (October-Decem[illegible]), 331-338.

169. Morris, K. R. S. "New Frontiers to Health in Africa," Science, CXXXII (September 19, 1960), 652-658.

170. Odhiambo, T. R. "East Africa: Science for Development," Science, CLVIII (November 17, 1967), 876-881.

171. Pereira, H. C. "The Integration of Research Agencies for African Agricultural Development," Minerva, IX (January, 1971), 38-45.

172. Phillips, John. Agriculture and Ecology in Africa: A Study of Actual and Potential Development South of the Sahara. New York: Praeger, 1960, 423.

173. Snowball, George J., ed. Science and Medicine in Central Africa. New York: Pergamon, 1965, 1008.

174. United Nations Educational, Scientific, and Cultural Organization. Outline of a Plan for Scientific Research and Training in Africa. Paris: UNESCO, 1964, 25.

175. ________. The Promotion of Scientific Activity in Tropical Africa, Paris: UNESCO, 1969, 118.

176. ________. The Teaching of Sciences in African Universities. Paris: UNESCO, 1964, 112.

177. ________. In Association with United Nations Economic Commission for Africa. Scientific Research in Africa: National Policies, Research Institutions. Paris: UNESCO, 1966, 221.

178. Wilson, Charles M. "That More People May Live Better," Scientific Monthly, LXV (September, 1947), 199-206. Describes the Liberian Institute, an international medical research center.

179. Wood, Alan. The Groundnut Affair. London: Badley Head, 1950, 264.

180. Worthington, E. Barton. Science in Africa. London: Oxford University Press, 1938, 746.

181. ______. Science in the Development of Africa. London: Commission for Technical Cooperation in Africa South of the Sahara and Scientific Council for Africa South of the Sahara, 1958, 462.

China

182. Buck, J. Lossing. "Fact and Theory about China's Land," Bulletin of the Atomic Scientists, VI (December, 1950), 365-368.

183. Chan, Alfred Z. "Scientists in Communist China," Science, CXIX (June 4, 1954), 785-789.

184. Chang, P. H. "China's Scientists in the Cultural Revolution," Bulletin of the Atomic Scientists, XXV (May, 1969), 19-20; 40.

185. Cheng, Chu-Yuan. Scientific and Engineering Manpower in Communist China, 1941-1963. Washington, D.C.: National Science Foundation, 1965, 588.

186. Christiansen, W. M. "Science and Scientists in China Today," Scientific Research, II (October, 1967), 64-68.

187. Croizier, Ralph C. Traditional Medicine in Modern China: Science, Nationalism, and the Tensions of Cultural Change. Cambridge, Massachusetts: Harvard University Press, 1968, 325.

188. Dean, G. C. "Science and the Thought of Chairman Mao," New Scientist, LXV (February 12, 1970), 298-299.

189. Dedijer, Stevan and A. Rahman. Research Potential and Science Policy of the People's Republic of China: A Bibliography. Lund, Sweden: Research Policy Library; New Delhi, India: Research Policy Library, 1969, 39.

190. Esposito, Bruce J. "Science in Mainland China," Bulletin of the Atomic Scientists, XXVIII (January, 1972), 36-40.

191. Gould, Sidney H., ed. Sciences in Communist China. Washington, D.C.: American Association for the Advancement of Science, 1961, 872.

192. Guillain, Robert. "Ten Years of Secrecy," Bulletin of the Atomic Scientists, XXI (February, 1965), 24-25.

193. Halperin, Morton H. China and the Bomb. New York: Praeger, 1965, 166.

194. Hsieh, Alice L. Communist China's Strategy in the Nuclear Era. Englewood Cliffs, New Jersey: Prentice-Hall, 1962, 204.

195. Huard, Pierre and Ming Wong. Chinese Medicine. Trans. from the French. New York: McGraw-Hill, 1968, 253.

196. Inglis, David R. "The Chinese Bombshell," Bulletin of the Atomic Scientists, XXI (February, 1965), 19-21.

197. Klochko, Mikhail A. Soviet Scientist in Red China. New York: Praeger, 1964, 213.

198. Kwok, D. W. Y. Scientism in Chinese Thought 1900-1950. New Haven, Connecticut: Yale University Press, 1965, 231.

199. Lall, Arthur S. "The Political Effects of the Chinese Bomb," Bulletin of the Atomic Scientists, XXI (February, 1965), 21-24.

200. McFarlane, B. "Mao's Game Plan for China's Industrial Development," Innovation (August, 1971), 3-13.

201. Macioti, M. "China Uses Science Policy 'to Walk on Two Legs'," Science Policy News, II (May, 1971), 70-71.

202. ________. "Hands of the Chinese," New Scientist and Science Journal, L (June 10, 1971), 636-639.

203. Margolis, Howard. "From Washington: The Bomb in China," Bulletin of the Atomic Scientists, XX (December, 1964), 36-39.

204. Maru, R. Research and Development in India and China: A Comparative Analysis of Research Statistics and Research Effort. Occasional Paper No. 1. Lund, Sweden: Research Policy Program; New Delhi, India: Center for the Study of Developing Societies, 1969, 71.

205. Murphy, Charles H. "Mainland China's Evolving Nuclear Deterrent," Bulletin of the Atomic Scientists, XXVIII (January, 1972), 28-35.

206. Needham, Joseph. Science and Civilization in Ancient China. London: Cambridge University Press, 1954-1965.

207. Needham, Joseph, with Wang Ling, et al. Clerks and Craftsmen in China and the West: Lectures and Addresses on the History of Science and Technology. Cambridge, England: Cambridge University Press, 1970, 470.

208. Needham, Joseph, with the collaboration of Wang Ling and Lu Gwei-Djen. Science and Civilization in China. Volume 4: Physics and Physical Technology. Part 3: Civil Engineering and Nautics. London and New York: Cambridge University Press, 1971, 932.

209. Oldham, C. H. G. "Science in Mainland China: A Tourist's Impressions," Science, CXLVII (February 12, 1965), 706-714.

210. ________. "Science Travels the Mao Road," Bulletin of the Atomic Scientists, XXV (February, 1969), 80-83.

211. Orleans, Leo A. Professional Manpower and Education in Communist China. Washington, D.C.: U.S. Government Printing Office, 1969, vii, 260.

212. Pei-Sung, Tang. Green Thraldom: Essays of a Chinese Biologist. London: Allen and Unwin, 1949, 127.

213. Ryan, William L. and Sam Summerlin. The China Cloud: America's Tragic Blunder and China's Rise to Nuclear Power. Boston: Little, Brown, 1968, 309.

214. Scientific Research. "Two Kinds of Scientists in China: Maoists Do Well," Scientific Research, II (October, 1967), 71-72.

215. Shapley, Deborah. "Chinese Science: What the China Watcher's Watch," Science, CLXXIII (August 13, 1971), 615-617.

216. Signer, Ethan and Arthur W. Galston. "Education and Science in China," Science, CLXXV (January 7, 1972), 15-28.

217. Suttmeier, R. P. "Party Views of Science: The Record of the First Decade," China Quarterly, Number 41 (October-December, 1970), 146-168.

218. Suyin, Han. China in the Year 2001. New York: Basic Books, 1967, 268.

219. Thompson, H. W. "Science in China," International Science and Technology, Number 18 (June, 1963), 86-95.

220. Uchida, G. "Technology in China," Scientific American, CCXV (November, 1966), 37-45.

221. Wang, Chi. "Nuclear Research in Mainland China," Nuclear News, X (May, 1967), 16-20.

222. Wu, Yuan-Li. The Steel Industry in Communist China. New York: Praeger, for the Hoover Institute on War, Revolution, and Peace, 1965, 334.

223. Wu, Yuan-Li and Robert B. Sheeks. The Organization and Support of Scientific Research and Development in Mainland China. New York: Praeger, 1970, 594.

India and Pakistan

224. Baranson, Jack. Manufacturing Problems in India: The Cummins Diesel Experience. Syracuse, New York: Syracuse University Press, 1967, xix, 146.

225. Barnaby, F. "India's Nuclear Views," New Scientist and Science Journal, XLIX (February 4, 1971), 268-269.

226. Gilchrist, Huntington. "Technical Assistance from the United Nations as Seen in Pakistan," International Organization, XIII (Winter, 1959), 505-519.

227. International Science and Technology. "India's Development Strategy," International Science and Technology, Number 22 (October, 1963), 93-98. Interview with Homi J. Bhabha, Chairman of India's Atomic Energy Commission.

228. Kahn, Mohammed A. "Education and Research in Pakistan," Impact of Science on Society, XIX (January-March, 1969), 85-92.

229. Maheshwari, P. "Indian Scientific Policy--Science and Government," Minerva, III (Autumn, 1964), 99-113.

230. Minerva. "Indian Science Policy," Minerva, II (Summer, 1964), 519-530.

231. ________. "Indian Scientific Policy," Minerva, II (Winter, 1964), 242-256; "A Scientific Policy Resolution," Government of India, March 4, 1958, 242-244; "Recommendations of the Conference Held on the 18th and 19th July 1958, under the Auspices of the Ministry of Scientific Research and Cultural Affairs, to Consider Implementation of the Scientific Policy Resolution of the Government of India," 245-246; "Address," Dr. Humayan Kabir, August 4, 1963, at a Conference of Scientists and Educationists to review the Implementation of the Scientific Policy Resolution of the Government of India of 1958, 247-256.

232. Morehouse, Ward. Science in India: Institution Building and the Organizational Systems for Research and Development. Bombay: Popular Prakashan, 1971, 144.

233. Morehouse, Ward, ed. Science and the Human Condition in India and Pakistan. New York: Rockefeller University Press, 1968, xvii, 230.

234. Mukerjee, Dilip. "Indian Science: Policy, Organization, and Application," Minerva, II (Spring, 1964), 360-369.

235. Nanda, Krish. "Will India Go Nuclear?" Bulletin of the Atomic Scientists, XXVII (December, 1971), 39-41.

236. National Academy of Sciences-National Research Council. East Pakistan Land and Water Development as Related to Agriculture. A Report of an ad hoc Panel of the Board of Science and Technology for International Development of the National Academy of Sciences-National Research Council prepared for the Agency for International Development. Washington, D.C.: Office of the Foreign Secretary, National Academy of Sciences, 1971, 67.

237. Pakistan. Ministry of Industries. "Report of the Scientific Commission of Pakistan," Minerva, I (Autumn, 1962), 75-86.

238. Parthasarathi, Ashok. "Appearance and Reality in Indian Science Policy," Nature, CCXXI (March 8, 1969), 909-911.

239. Rahman, A. "National Laboratories in India," Nature, CCIII (August 8, 1964), 582-584.

240. Rahman, A., N. Sen, and N. R. Rajagopal. "Scientific Scientists in India," Nature, CCIV (December 26, 1964), 1250-1252.

241. Ranganathan, A. "Science in Modern India," Impact of Science on Society, IX (Number 4, 1959), 210-230.

242. Salam, Abdus. "Pakistan: The Case for Technological Development," Bulletin of the Atomic Scientists, XXI (March, 1964), 2-5.

243. Scientific Research. "Short of Science Funds, India Pares Basic Research," Scientific Research, II (October, 1967), 25.

244. Singh, Jagjit. "Scientific Research in India," Bulletin of the Atomic Scientists, XXI (February, 1965), 41-43.

245. Strauss, Herbert L. "Science Education in India," Bulletin of the Atomic Scientists, XXVII (March, 1971), 10-13.

246. Swaminathan, V. S. "Scientific and Industrial Research in India," American Scientist, LII (October, 1954), 625-638.

247. United Nations Educational, Scientific, and Cultural Organization. South Asia Science Cooperation Office: Scientific Institutions and Scientists in Pakistan. New Delhi: UNESCO, 1958, 501.

248. Watson, Ernest C. Organization of Scientific Activities in India. Washington, D.C.: National Science Foundation, 1962, 29.

249. Wilson, Patrick. Science in South Asia, Past and Present: A Preliminary Bibliography of Writings on Science in India, Pakistan, and Ceylon, New York: State University of New York, State Education Department, 1966, 100.

Japan

250. Aviation Week and Space Technology. "Japanese Aerospace Industry Nears Parity with the West," Aviation Week and Space Technology, XCV (November 1, 1971), 34-37.

251. Aviation Week and Space Technology. "Realigned National Space Program Adopted by Japanese," Aviation Week and Space Technology, XCV (November 1, 1971), 64-66.

252. Boffey, Philip M. "Japan (I): On the Threshold of an Age of Big Science," Science, CLXVII (January 2, 1970), 31-35; "Japan (II): University Turmoil is Reflected in Research," Ibid. (January 9, 1970), 147-152; "Japan (III): Industrial Research Struggles to Close the Gap," Ibid. (January 16, 1970), 264-267.

253. ________. "Research in Japan: U.S. Army Grants Cause Controversy," Science, CLVIII (November 10, 1967), 748-752.

254. Campbell, Louise. "Science in Japan," Science, CXLIII (February 21, 1964), 776-782.

255. Fukushima, Yoichi. "Japan's Five-Year Science Plan," New Scientist, XXXII (October 27, 1966), 178-180.

256. Glass, H. Bentley. "The Japanese Science Education Centers," Science, CLIV (October 14, 1966), 221-228.

257. Hall, George R. and Robert E. Johnson. Transfers of United States Aerospace Technology to Japan. Santa Monica, California: RAND Corporation, 1968, 95.

258. Imai, Ryukichi. "Japan and the Nuclear Age," Bulletin of the Atomic Scientists, XXVI (June, 1970), 35-39.

259. International Science Notes. "Japan's Science and Technology: Trends and Forecasts," International Science Notes, Number 24 (March, 1970), 1-5.

260. Japan. Science and Technology Agency. Japanese Science Policy in the 1970's. A Report of the Council for Science and Technology. Tokyo: Planning Bureau, Science and Technology Agency, Prime Minister's Office, 1971.

261. ________. Science and Technology Agency: An Outline. Tokyo: Planning Bureau, Science and Technology Agency, Prime Minister's Office, 1971.

262. Japan. Science and Technology Agency. Summary of White Paper on Science and Technology--New Demands on Technical Innovation. Tokyo: Planning Bureau, Science and Technology Agency, Prime Minister's Office, 1971, 76.

263. Jequier, N. "Towards a Technological Policy: The Japanese Model," Science Policy News, III (July, 1971), 1-5.

264. Karsh, Bernard and Robert E. Cole. "Industrialization and the Convergence Hypothesis: Some Aspects of Contemporary Japan," Journal of Social Issues, XXIV (October, 1968), 45-63.

265. Komai, Taku. "Science and Freedom in the Orient," Bulletin of the Atamic Scientists, X (June, 1954), 209-210; 214.

266. Livermore, Arthur H., ed. Science in Japan. Washington, D.C.: American Association for the Advancement of Science, 1965, 486.

267. Long, T. D. "Policy and Politics in Japanese Science: The Persistence of a Tradition," Minerva, VII (Spring, 1969), 426-453.

268. ________. "Science Policy in Japan," OECD Observer, Number 28 (June, 1967), 32-37.

269. Makay, A. "An Outsider's View of Science in Japan," Impact of Science on Society, XII (Number 3, 1962), 177-202.

270. Nakane, Chie. Japanese Society. Berkeley: University of California Press, 1970, 158.

271. OECD Observer. "The Energy Policy of Japan," OECD Observer, Number 48 (Octover, 1970), 15-18.

272. Organization for Economic Cooperation and Development. Reviews of National Science Policy: Japan. Paris: OECD, 1967, 231.

273. Physics Today. "Physics in Japan: Budgets Still Meager Despite Economic Boom," Physics Today, XXIV (August, 1971), 69-71.

274. Tuge, Hideomi, ed. Historical Development of Science and Technology in Japan. Tokyo: Society for International Cultural Relations, 1961, 200.

275. Yoshino, M. Y. Japan's Managerial System: Tradition and Innovation. Cambridge, Massachussets: M.I.T. Press, 1968, 292.

Latin America

276. Adams, R. N. "Politics and Social Anthropology in Spanish America," Human Organization, XXIII (Spring, 1964), 1-4.

277. Hawkes, Nigel. "Chile: Planning for Science Faces Obstacles Old and New," Science, CLXXIV (December 17, 1971), 1217-1219.

278. Mexico. Office of the President. "The National Council for Science and Technology," Mexican Newsletter, Office of the President, separata 2, 1971, 15.

279. Nussenzveig, H. Moyse's. "Migration of Scientists from Latin America," Science, CLXV (September 26, 1969), 1328-1332.

280. Ryder, Walter D. "How Cuba Manages Its Science," New Scientist, XLIV (November 13, 1969), 339-341.

281. ________. "Lessons of Castro's Cuba," New Scientist, LII (December 30, 1971), 262-265.

282. Schulman, Sam. "Intellectual and Technological Underdevelopment: A Case Study--Colombia," Social Forces, XLVI (March, 1968), 309-317.

283. Strassman, W. Paul. Technological Change and Economic Development: The Manufacturing Experience of Mexico and Puerto Rico. Ithaca, New York: Cornell University Press, 1968, 353.

284. Tellex, T. "Mexican Science: A New Era?" Bulletin of the At[illegible] Scientists, XXIV (April, 1968), 46-48.

285. United Nations Educational, Scientific, and Cultural Organization. Guideline for the Application of Science and Technology to Latin American Development. Final Report of the Conference on the Applications of Science and Technology to the Development of Latin America. Organized by UNESCO with the cooperation of the Economic Committee for Latin America, Santiago, Chile. September 13-22, 1965. Paris: UNESCO, 1965, 250.

286. United Nations Educational, Scientific and Cultural Organization. World Directory of National Science Policy-Making Bodies, Vol. 3: Latin America. Paris: UNESCO, 1968, 187.

Middle East

287. Allison, Samuel K. "Physics in Egypt: A New Type of Lend-Lease," Bulletin of the Atomic Scientists, XVI (October, 1960), 317-321, 335.

288. Greenberg, Daniel S. "Mideast Science Gap Widening," Science Policy Reviews, IV (1971), 21-27.

289. Ismail, Abdel F. "Current Trends in Science Policy in the United Arab Republic," Impact of Science on Society, XII (Number 2, 1962), 103-118.

290. Langley, K. M. Industry in Iraq. Cambridge, Massachusetts: Harvard University Press, 1961, 313.

291. Lenczowski, G. Oil and State in the Middle East. Ithaca, New York: Cornell University Press, 1960, 379. Biblio.

292. Qubain, Fahim I. Education and Science in the Arab World. Baltimore: Johns Hopkins Press, 1966, 608.

293. Rahnema, Mavid. "Iran: Science Policy Development," Impact of Science on Society, XIX (January-March, 1969), 53-61.

294. Tauber, Gerald E. Scientific Endeavor of Israel: Teaching, Resources, Research. New York: Herzl Press, 1961, 80.

295. U.S. Department of State. Science and Technology in Israel. Department of State Airgram No. A-448 from American Embassy, Tel Aviv, November 28, 1970. Washington, D.C.: Bureau of International Commerce, U.S. Department of Commerce, 1970, 4.

296. Worthington, D. B. Middle East Science: A Survey of Subjects Other than Agriculture. London: Her Majesty's Stationery Office, 1946, 239.

297. Zahlan, A. B. "The Acquisition of Scientific and Technological Capabilities by Arab Countries," Bulletin of the Atomic Scientists, XXV (November, 1969), 7-10.

298. Zahlan, A. B. "Science in the Arab Middle East," Minerva, VIII (January, 1970), 8-35.

Southeast Asia

299. Bhathal, R. S. "Science and Government in Singapore," Bulletin of the Atomic Scientists, XXVII (January, 1971), 20-21; 38.

300. ________. "Science and Technical Education in Asia," New Scientist and Science Journal, L (June 24, 1971), 729-730.

301. Cortes, J. R. "Factors Associated with the Migration of High-Level Persons from the Philippines to the U.S.A.," Science Review, XI (January-February, 1970), 3-17.

302. Dessau, Jan. "Social Factors Affecting Science and Technology in Asia," Impact of Science on Society, XIX (January-March, 1969), 13-23.

303. Eversull, Frank L. "Korean Scientists Organize," Scientific Monthly, LXV (September, 1947), 243-245.

304. Galston, Arthur W. and Ethan Signer. "Education and Science in North Vietnam," Science, CLXXIV (October 22, 1971), 379-385.

305. Hemptinne, Yvan de, ed. "Science in a Changing Asia," Impact of Science on Society, XIX (January-March, 1969), entire issue.

306. Hermano, R. A. D. "Some Notes on the National Science Policy of the Philippines," Philippine Science Review, XI (March-April, 1970), 13-20.

307. Kim, Kee-Hyong. "Korea's Strategy for Science and Technology," Impact of Science on Society, XIX (January-March, 1969), 98-98.

308. Nicholls, Frank G. and P. Cheosakul. "Harnessing Science to Development in Thailand," Impact of Science on Society, XIX (January-March, 1969), 75-84.

309. Noble, Glenn A. "Science Education in Korea," Science, CVII (January 9, 1948), 31-32.

310. Pecson, Geronima T. "The Good and Bad of Science and Technology," Impact of Science on Society, XIX (October-December, 1969), 363-370.

311. Rose, Steven and Hilary Rose. "Science in North Vietnam," New Scientist and Science Journal, XLIX (January 21, 1971), 134-136.

312. Schenck, Hubert G. "Impact of Sciences in East Asia," Bulletin of the Atomic Scientists, XIV (September, 1958), 273-275.

313. United Nations Educational, Scientific, and Cultural Organization. National Science Policies in Countries of South and South-East Asia. A comparative study based on the proceedings of the Third Regional Meeting of Representatives of National Scientific Research Organizations of South and South-East Asia at Canberra, Australia, February, 1964. Paris: UNESCO, 1965, 45.

314. ________. National Science Policy and Organization of Research in the Philippines. Paris: UNESCO, 1970, 116.

315. White, Gilbert F. "The Mekong River Plan," Scientific American, CCVIII (April, 1963), 49-59.

LEADING QUESTIONS

1. What have been the principal effects of science and science-based technology on non-Western traditional cultures? Is there a "scientific culture" distinct and separable from Western traditional culture?

2. Have certain of these effects been inherent in contradictions between science and traditional culture, or have they followed from the manner of the introduction of science and advanced technology, or both?

3. What were the objectives of the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas? What were the achievements of the conference? What were its significant omissions?

4. What factors seem to influence the extent to which science and advanced technology are accepted (or rejected) in traditional societies? What may explain the contrasting reception of Western science in Japan, China, India, Indonesia, and the Arab states?

5. Is science, as a method of thought, consistent with the political assumptions underlying the creation of new "sovereign" nations in Africa and Asia?

6. What are the principal obstructions to the development of science in traditional cultures where there is no overt opposition to science per se--in much of Central and South America, for example?

7. What are the more important institutional arrangements for introducing and cultivating science in newly emerging nations? E.g., what international organizations or agreements have been developed to assist this process?

8. Are scientific and economic developments always compatible in the new nations--or have there been conflicting effects? Can you cite specific examples of incompatible objectives?

9. Can the development process be made amenable to broad-based scientific concepts and methods? If so, how might this be accomplished and where should the initiative be located?

10. Given the present exponential growth of science and advanced technology in Westernized countries, is there any real prospect that the new nations can "catch up" with the more advanced societies--or will the knowledge gap widen?

III

POLICY PROBLEMS OF SCIENCE AND TECHNOLOGY

The five topics comprising this section cover some of the larger problem areas of public policy that have resulted from the advancement of science and technology. In Topics 11, The Politics of Science and Technology, and 12, Administration of Research and Development, emphasis is on establishing the direction, priorities, and allocations of money for scientific and technological development in the United States. In the remaining topics of this section American experience is also emphasized, but attention is given to policy problems in other national contexts. Topic 13 is closely related as it examines methods of controlling the direction of technoscientific development and its effects on planning for the tested application of selected technologies. Topics 14, Science, Human Rights, and the Role of Law, and 15, Managing the Technoscientific Superculture, deal with policy problems growing out of the impact of science and technology upon the lives of individuals. Advancements in medicine, engineering, genetics, pharmacology, and industrial chemistry have given rise to novel circumstances in which the rights of individuals and of society cannot always be defined by historical precedent. The focus of all topics in this section is upon problems generated by the growth of technoscience, and the policy issues that arise in consequence of these problems and of the efforts of society to cope with them.

TOPIC 11 THE POLITICS OF SCIENCE AND TECHNOLOGY

Although the formal structures of government-science relationships may be studied comparatively, it is more difficult to compare (in any detail) the actual course of politics through which a nation's policies for science and technology are shaped. In any nation, the development of science and technology has been influenced by unique factors of history, institutions, and personal leadership. Science policy is seldom shaped primarily out of concern for the advancement of knowledge. In the United States, no less than in other countries, considerations of national security, economic growth, fear of illness, and international prestige have influenced the direction of science policy.

In the United States, the politics of science during the 19th century was strongly influenced by rivalry among several leading scientists. Political attitudes toward the Federal role in science reflected popular beliefs regarding the proper functions of government in general, and the Federal government in particular. The principal scientific functions of government were in pursuance of other objectives, chiefly military in the years before the Civil War. In the post-Civil War years, agriculture became a major focus for applied science and, at the close of the century, the conservation of natural resources emerged as a related field for the application of scientific knowledge.

It was not until science assumed the proportions of a major national enterprise in the years following World War II that it became a significant political issue. Its increasing importance explains its growing political involvement--a relationship that some scientists have been reluctant to concede. In the immediate post-War period, questions of how to manage the recently liberated energy of the atom were paramount, followed by debate over the nature of a national institution to promote the advancement of science. The Atomic Energy Commission (1946) and the National Science Foundation (1950) were outcomes of these political issues. This post-War era also saw the expansion of the National Institutes of Health into one of the world's greatest biomedical research establishments.

Success of the Soviet Sputnik in 1957 stimulated new efforts to strengthen physical science and led directly to the Space Program and establishment of the National Aeronautics and Space Administration. The structure of advice and coordination for Federal science policy became a political issue, and led to structural innovations. But increasingly, the politics of science and technology reflected public concern over the wise use of knowledge. Among the political issues affecting the direction of science policy have been nuclear fallout, pesticides, environmental pollution, dangerous drugs, Supersonic Transport, and the national investment in basic science. Arguments have been advanced from several sources for a high-level review of the consequences of scientific and technical innovation. By the early nineteen seventies there was widespread concern in most scientifically advanced countries over priorities in scientific research and development, and for better ways to determine them. (See Topic 12)

TOPIC 11 THE POLITICS OF SCIENCE AND TECHNOLOGY

Selected Basic Readings:

Blume, Stuart S. "Science Policy and Science Policy Research," Nature, CCXXVIII (October 17, 1970), 215-218.

Greenberg, Daniel S. "The New Politics of Science," Technology Review, LXXIII (February, 1971), 41-45.

Long, T.D. "The Government of Science: A Comparative Approach," Science Studies, I (October, 1971), 263-286.

Pitzer, Kenneth S. "Science and Society: Some Policy Changes Are Needed," Science, CLXXII (April 16, 1971), 223-226.

Price, Don K. "Science at a Policy Crossroads," Technology Review, LXXIII (April, 1971), 31-37.

Supplementary and Substitute Readings:

Etzioni, Amitai and Richard Remp. "Technological 'Shortcuts' to Social Change," Science, CLXXV (January 7, 1972), 31-38.

Jensen, Edwood V. "The Science of Science," Perspectives in Biology and Medicine, XXII (Winter, 1969), 274-289.

Kass, Leon R. "The New Biology: What Price Relieving Man's Estate?" Science, CLXXIV (November 19, 1971), 779-787.

King, Alexander. "Science Policy, Economic Growth, and the Quality of Life," Science Policy News, II (July, 1970), 1-6.

Leitenberg, Milton. "The Present State of the World's Arms Race," Bulletin of the Atomic Scientists, XXVIII (January, 1972), 15-21.

Orlans, Harold. "Social Science Research Policies in the United States," Minerva, IX (January, 1971), 7-31.

TOPICAL OUTLINE	REFERENCE KEY
I. Politics and Science in the United States	175, 178, 285, 356, 359
A. Historical relationships (Cf. Topic 06)	26, 289, 326, 358
B. Contrasting values of science and politics	153
1. Scientific enterprise involved in the socio-political matrix of the times, but with its own values and assumptions	371, 381
2. Political and scientific criteria for truth--a contrast	308
3. Defining the public welfare--differing approaches of science and of politics	204
C. Mutual dependence of science and politics in the technoscientific society	49, 145, 148, 177, 213, 290, 291, 314, 350, 391, 418
II. The Politics of the Contemporary Structure for Science Policy	56, 74, 75, 76, 275, 300, 303, 345
A. Precursors of a new status for science	44
1. Changed international position of the United States	53, 311
2. Vannevar Bush Report to the President: Science--The Endless Frontier, 1945	409
3. Science and Public Policy, report of the President's Scientific Research Board, John R. Steelman, Chairman, 1947	411
4. Establishment of the Atomic Energy Commission, 1946	299
5. Establishment of the National Science Foundation, 1950	4, 90, 394

B. The changing role of science in American society	2, 52, 298
1. Heavy increase in defense-related R & D	129, 198, 315, 317, 380, 391, 403
2. Relationship to economic growth (Cf. Topic 05)	267, 327, 335, 392
3. Recognition of the value of basic science	82, 119
4. Role of immigrant scientists in the development of indigenous science competence in the United States	78, 152, 179, 292, 294
C. Post-Sputnik reorganization and development, 1957	44, 247, 314
1. The Space Program, NASA, 1958	249, 336, 339, 393, 394, 400, 401, 410, 412
2. New proposals for a department of science (Cf. Topic 06)	
3. Government stimulation of science education (Cf. Topic 05)	151, 162, 230, 340, 381
4. The new structure of science advice (Review Topic 06)	1, 6, 61, 79
a. Special Assistant to the President for Science, 1957	91
b. Federal Council for Science and Technology, 1959	
c. Office of Science and Technology, 1962	
d. Reorganization Plan No. 2 of 1962 (Note summary in Penick, The Politics of American Science, 229-232)	356
5. Concentration of scientific programs and support	34, 95, 165
a. In particular sciences and technologies	141, 222, 224, 343
b. In particular geographic locations	28, 300
c. In particular institutions	28, 234
6. Inadequate opportunity for public participation in the consideration of alternatives and setting of priorities	35, 73, 262, 316, 318

7. Hazards and safeguards of American science policy from	102, 106
a. Manipulation by highly organized and influential groups for group-centered interests--military, industrial, academic	45, 48, 80, 113, 117, 172, 246, 256, 270, 290, 305, 320, 420
b. Neglect of areas of research of greatest social need in favor of areas of highest interest and prestige	29, 108, 120, 138, 141, 224, 251, 267, 414
III. The Larger Dimensions of Science Policy	13, 24, 68, 89, 105, 112, 124, 128, 144, 164, 184, 244, 254, 255, 289, 300, 353, 361
A. Competition for available funds	262, 290, 328, 414, 420
1. Advantageous position of defense and energy-related science and technology	9, 55, 114, 125, 158, 198, 253, 297, 310, 328, 360, 366, 383, 386
2. Health research: medicine versus basic biology	108, 150, 225, 286, 334
3. Handicaps of social and environmental studies	39, 40, 81, 83, 131, 132, 146, 163, 189, 219, 245, 257, 269, 322, 333, 344
4. Limited sources of support for basic as opposed to applied research	62, 63, 135, 207
B. Responsibility for formulation of public policy for science and technology	56, 171, 193, 197, 329, 418

1. Relating science policy to science advice	42, 69, 109, 130
2. Determining the extent to which scientific knowledge will influence political decisions	115, 368
3. Fixing responsibility in the R & D triangle, e.g., government, universities, industry	127, 162, 318, 352
4. Responsibilities of the Federal and State governments--the case of the U.S. Atomic Energy Agency vs. Minnesota	14
5. Surveying, assessing, and interpreting the status of science and technology (Cf. Topic 13)	29, 351
IV. Policy Problems in the Utilization and Control of Science and Technology--Some Illustrative Cases	51, 108, 236, 263, 266, 281, 284, 287, 304, 309, 337, 341, 348, 365, 368, 378, 382
A. Public policy and the integrity of the scientist	
1. The Robert Oppenheimer Affair	276, 278, 301, 325, 330, 374
2. The AD-X2 Battery Addictive Case	
3. Fluoridation of water supplies	191
4. The Krebiozen Case	
5. Blacklisting of scientists by HEW	155, 156
6. The Franklin A. Long incident	15, 16
7. Rachel Carson and the agricultural scientists	33, 85, 159, 268
8. Standards for nuclear radiation	67, 70, 160, 182, 218
9. The Velikovsky controversy	
10. The Agri-statistics Case	
B. Social sensitivity and scientific curiosity	258, 302, 377
1. Darwinian Evolution: The Scopes Trial	

2. Genetics of human differences	98, 126, 168, 194, 282, 312
3. Genetic engineering	58, 101, 143, 154, 208, 354
4. Sexual behavior of human beings	11, 58, 142
5. Social research as "spying": Project Camelot	92, 306
6. Reformist research, e.g., Public Interest Investigations	
7. Experimentations with human subjects	259, 355
C. Alteration of the natural environment	30, 31, 38, 43, 56, 60, 245, 274, 277, 296, 324, 362, 373, 375
1. Air pollution	170, 235
2. Water pollution	17, 27, 84, 133
3. Solid wastes	77, 186, 407
4. Pesticides and herbicides	33, 85, 86, 157, 159, 169, 220, 226, 241, 389
5. Inorganic fertilizers	104
6. Scientific forestry	
7. Rainmaking	134
8. Defoliation	71
9. Supersonic Transport	47, 138, 185, 243, 376, 383, 397
10. The Trans-Alaska Pipeline	7, 8, 149
11. Experiments in space: Projects Argus, Starfish, and West Ford	
12. Nuclear radiation	32, 67, 188, 217, 218, 232, 239
D. "Social" drugs, science, and morality	51, 280, 295, 321
1. Tobacco	
2. Marijuana	231, 372
3. Hallucinogens and LSD	142, 250, 261, 279
4. Alcohol	51
E. Use of data processing techniques to collect and disseminate information on all citizens--possible invasion of privacy	25, 80, 140, 187, 192, 346, 364, 390, 404, 413, 416

F. Choice, emphasis, and alternatives in technological development	46, 234, 291, 417
1. The Space Program: objectives, methods, duration	10, 20, 23, 224, 242, 247, 336, 400, 410, 412
2. Transportation: specific modes versus public systems	3, 9, 37, 47, 136, 138, 200, 210, 216, 229, 240, 266, 383, 408
3. Automation and cybernetics: machines versus manpower	21, 413, 416
4. Weapons technology: cost-effectiveness, realiability, and morality	45, 96, 103, 125, 158, 167, 180, 246, 248, 265, 271, 273, 283, 290, 305, 332, 384, 385, 399, 405
5. Energy: how much, from what, for what?	32, 47, 64, 97, 149, 238, 398, 406, 419

BIBLIOGRAPHY

General References: Articles

1. Abelson, Philip H. "The President's Science Advisers," Minerva, III (Winter, 1965), 149-158.

2. Adams, J.B. "Megaloscience," Science, CXLVIII (June, 1965), 1560-1564.

3. Agnew, Spiro T. "Urban Fast Mass Transportation," Congressional Record, CXVII (September 14, 1971), E9562-E9564.

4. Allison, David. "The National Science Foundation," International Science and Technology, Number 52 (April, 1966), 76-86.

5. Alpert, Harry. "The Government's Growing Recognition of Social Science," Annals of the American Academy of Political and Social Science, CCCXXVII (January, 1960), 59-67.

6. Anderson, Clifton P. "Scientific Advice for Congress," Science, CXLIV (April 13, 1964), 29-32.

7. Aspin, L. "The Borden Report on the Trans-Alaska Pipeline," Congressional Record, CXVII (June 15, 1971), H5226-H5228.

8. ________. "Why the Trans-Alaska Pipeline Should be Stopped," Congressional Record, CXVII (August 6, 1971), E9062-E9064.

9. Aviation Week and Space Technology. "Special Report on Satellite Communications," Aviation Week and Space Technology, XCV (August 23, 1971), 28-95.

10. Bean, A.L. "The Value of Manned Flights to the Moon," Impact of Science on Society, XXI (April-June, 1971), 105-112.

11. Bernard, Jessie. "Technology, Science, and Sex Attitudes," Impact of Science on Society, XVIII (October-December, 1968), 213-228.

12. Bethe, Hans A. "Disarmament Problems," Bulletin of the Atomic Scientists, XXVI (June, 1970), 99-102.

13. Blume, Stuart S. "Science Policy and Science Policy Research," Nature, CCXXVIII (October 17, 1970), 215-218.

14. Boffey, Philip M. "Radioactive Pollution: Minnesota Finds AEC Standards Too Lax," Science, CLXIII (March 7, 1969), 1043-1044; 1046.

15. Boffey, Philip M. and Bryce Nelson. "NSF Director: Nixon Admits He Was Wrong," Science, CLXIV (May 2, 1969), 532-534.

16. ________. "NSF Directorship: Why Did Nixon Veto Franklin A. Long?" Science, CLXIV (April 25, 1969), 406-411.

17. Boyle, Clarence L. "Oil Pollution of the Sea: Is the End in Sight?" Biological Conservation, I (July, 1969), 319-327.

18. Brezina, Dennis W. "Wanted: A Science Policy Doctrine," Scientific Research, IV (December 22, 1969), 22-24.

19. Brodine, Virginia. "The Secret Weapons," Environment, XI (June, 1969), 12-26.

20. Brown, Allan H. "The Post-Apollo Era: Decisions Facing NASA," Bulletin of the Atomic Scientists, XXIII (April, 1967), 11-16.

21. Buckingham, Walter. "The Human Side of Automation," Cybernetics, IV (Number 1, 1961), 56-70.

22. Bulletin of the Atomic Scientists. "Disarmament and Arms Limitations: Pugwash Assessment," Bulletin of the Atomic Scientists, XXVII (March, 1971), 20-23.

23. ________. "Men on the Moon: An Assessment," Bulletin of the Atomic Scientists, XXV (September, 1969), entire issue.

24. Bundy, McGeorge. "The Scientist and National Policy," in Knowledge and Power: Essays on Science and Government, ed. by Sanford A. Lakoff. New York: Free Press, 1966, 420-431.

25. Carter, Luther J. "National Data Bank: Its Advocates Try to Erase 'Big Brother' Image," Science, CLXIII (January 10, 1969), 160; 162.

26. Chase, Edward T. "Politics and Technology," Yale Review, LII (March, 1963), 322-339.

27. Cheever, Daniel S. "Marine Science and Ocean Politics," Bulletin of the Atomic Scientists, XXVI (February, 1970), 22; 29-34.

28. Clarke, Robin. "How the 300 Ge V Decision Was Made," Science Journal, V (March, 1969), 4-5; 7.

29. Cohn, Victor. "Shaking Up The System," Technology Review, LXXIII (July-August, 1971), 8-9.

30. Cole, LaMont C. "Can the World Be Saved?" AIBS Bulletin (BioScience), XVIII (July, 1968), 679-684.

31. ________. "Thermal Pollution," AIBS Bulletin (BioScience), XIX (November, 1969), 989-992.

32. Commoner, Barry. "The Myth of Omnipotence," Environment, XI (March, 1969), 8-13; 26-28.

33. Conway, Gordon, et al. "DDT on Balance," Environment, XI (September, 1969), 2-5.

34. Cooper, Joseph D. "Onward the Management of Science: The Wooldridge Report," Science, CXLVIII (June 11, 1965), 1433-1439. (Report on the National Institutes of Health)

35. Cowen, R.C. "How Elitist Must Responsible Science Be?" Technology Review, LXXIII (February, 1971), 6-7.

36. Cox, Hiden T. "Scientists and Public Policy," AIBS Bulletin (BioScience), XIII (February, 1963), 14-16.

37. Craig, W.S. "Not A Question of Size," Environment, XII (June, 1970), 2-5.

38. Darling, Frank F. "Man against Nature," UNESCO Courier, XXII (January, 1969), 24-40.

39. David, Henry. "Behavioral Sciences and the Federal Government," American Psychologist, XXIV (October, 1969), 917-922.

40. De Grazia, Alfred. "The Government in Behavioral Science: Some Critical Notes," American Behavioral Scientist, VII (May, 1964), 25-31.

41. Delcoigne, Georges G. and G. Rubinstein. "Nonproliferation and Control: Peaceful Uses of Atomic Energy," Bulletin of the Atomic Scientists, XXVII (February, 1971), 5-7.

42. Doern, G. Bruce. "'Big Science', Government, and the Scientific Community in Canada: The ING Affair," Minerva, VIII (July, 1970), 357-375.

43. Dubos, René. "The Biosphere: A Delicate Balance between Man and Nature," UNESCO Courier, XXI (January, 1969), 7-15.

44. Dupree, A. Hunter. "Central Scientific Organization in the United States Government," Minerva, I (Summer, 1963), 453-469.

45. Dyson, Frederick J. "Arms Control and Technological Change," Congressional Record, CXVII, Part 11 (August, 1971), E8788-E8791.

46. ________. "The Death of a Project," Science, CXLIX (July 9, 1965), 141-144.

47. Eads, G. and R.R. Nelson. "Governmental Support of Advanced Civilian Technology: Power Reactors and the Supersonic Transport," Public Policy, XLIX (Summer, 1971), 405-427.

48. Elliott, Carl. "The Relationship between Industry, Its Research, and Government: The Legislative Point of View," Research Management, VIII (March, 1965), 65-75.

49. Ellul, Jacques. "Technique, Institutions, and Awareness," American Behavioral Scientist, XI (July-August, 1968), 38-42.

50. Engstrom, Elmer W. "Science, Technology, and Statesmanship," American Scientist, LV (March, 1967), 72-79.

51. Etzioni, Amitai and Richard Remp. "Technological 'Shortcuts' to Social Change," Science, CLXXV (January 7, 1972), 31-38.

52. Ezrahi, Ymon. "The Political Resources of American Science," Science Studies, I (February, 1971), 117-133.

53. Feinstein, Otto. "American Scholars Analyze U.S. Foreign Policy," Bulletin of the Atomic Scientists, XVI (December, 1960), 395-399.

54. Feld, Bernard T. "The Sorry History of Arms Control," Bulletin of the Atomic Scientists, XXVI (September, 1970), 22-26.

55. Feldman, N.E. and C.M. Kelley. "The Communication Satellite--A Perspective for the 1970s," Astronautics and Aeronautics, IX (September, 1971), 22-29.

56. Ferry, Wilber H. "Must We Rewrite the Constitution to Control Technology?" Saturday Review, LI (March 2, 1968), 52-54.

57. Firmage, Edwin B. "The Treaty on the Non-Proliferation of Nuclear Weapons," American Journal of International Law, LXIII (October, 1969), 711-746.

58. Fraccaro, Marco. "The Implications of Genetics for Procreation and Marriage," Impact of Science on Society, XVIII (October-December, 1968), 259-271.

59. Friedlander, Michael W. and Joseph Klarmann. "How Many Children?" Environment, XI (December, 1969), 2-8.

60. Frost, Justin. "Earth, Air, Water," Environment, XI (July-August, 1969), 14-33.

61. Galloway, Eilene. "Scientific Advice for Congress: Analysis of Three Proposals," in Knowledge and Power: Essays on Science and Government, ed. by Sanford A. Lakoff. New York: Free Press, 1966, 359-376.

62. Gibbons, M., S. Metcalf, and D. Watkins. "Basic Research: A Nation's Burden or Benefit?" Science Journal, VI (December, 1970), 71-74.

63. Gibbons, M., et al. "Value of Curiosity-Oriented Research," Nature, CCXXV (March 14, 1970), 1005-1008.

64. Gillette, Robert. "Schlesinger and the AEC: New Sources of Energy," Science, CLXXV (January 14, 1972), 147-151.

65. Gimlin, Hoyt. "Food Additives," Editorial Research Reports (December 26, 1969), 957-976.

66. Glass, H. Bentley. "Scientists in Politics," Bulletin of the Atomic Scientists, XVII (May, 1962), 2-7.

67. Gofman, John W. and Arthur R. Tamplin. "Radiation: The Invisible Casualties," Environment, XII (April, 1970), 12-19.

68. Goldsmith, Maurice. "The Autonomy of Science: Some Thoughts for Discussion," Political Quarterly, XXXVIII (January-March, 1967), 81-89.

69. Green, Edith. "Legislating in an Age of Science," in The Scientific Revolution: Challenge and Promise, ed. by Gerald W. Elbers and Paul Duncan. Washington, D.C.: Public Affairs Press, 1959, 30-36.

70. Green, Harold P. "'Reasonable Assurance' of 'No Undue Risk'," Scientist and Citizen, X (June-July, 1968), 128-140.

71. Greenberg, Daniel S., "Defoliation: AAAS Study Delayed by Resignations from Committee," Science, CLIX (February 23, 1968), 857-859.

72. ________. "How Science and Government Work Together in Washington," Research Management, VIII (March, 1965), 81-89.

73. ________. "Mohole: The Project That Went Awry," in Knowledge and Power: Essays on Science and Government, ed. by Sanford A. Lakoff. New York: Free Press, 1966, 87-111.

74. ________. "The New Politics of Science," Technology Review, LXXIII (February, 1971), 41-45.

75. ________. "The Politics of Pure Science," Saturday Review, L (November 4, 1967), 62-69.

76. ________. "The Press and the Politics of Science," Technology Review, LXX (May, 1968), 10-11.

77. Grinstead, Robert R. "No Deposit, No Return," Environment, XI (November, 1969), 17-23.

78. Grubel, Herbert G. "Foreign Scientists in the United States," Bulletin of the Atomic Scientists, XXVI (April, 1970), 9-12.

79. Handler, Philip. "Federal Science Policy," Science, CLV (March 3, 1967), 1063-1066.

80. Hanlon, Joseph. "The Implications of Project Cambridge," New Scientist and Science Journal, XLIX (February 25, 1971), 421-42[illegible]

81. Harris, Fred R. "Political Science and the Proposal for a National Social Science Foundation," American Political Science Review, LXI (December, 1967), 1088-1095.

82. Havens, William W., Jr. "Nuclear Research as a Source of Technology," Physics Today, XXI (September, 1968), 47-51.

83. Haworth, Leland J. "Support of Political Science by the National Science Foundation," American Political Science Review, LVIII (December, 1964), 1086-1088.

84. Hedgpeth, Joel W. "The Oceans: World Dump," Environment, XII (April, 1970), 40-46.

85. Henkin, Harmon. "DDT on Trial," Environment, XI (March, 1969), 14-17; 34-36.

86. ________. "Problems in PPM," Environment, XI (May, 1969), 24-25; 32-33; 37.

87. Hohenemser, Kurt. "Onward and Upward," Environment, XII (May, 1970), 22-27.

88. Hohenemser, Kurt and Julian McCaull. "The Windup Car," Environment, XII (June, 1970), 14-21; 32.

89. Holloman, J. Herbert. "Government and Science: How Science Policy is Developed," Science, CXLIII (January 31, 1964), 427-429.

90. Hornig, Donald F. "National Science Foundation," Chemical and Engineering News, XLIII (July 5, 1965), 62-65.

91. ________. "The President's Special Assistant for Science and Technology Addresses the American Physical Society," Physics Today, XVII (July, 1964), 34-38.

92. Horowitz, Irving L. "The Life and Death of Project Camelot," Transaction, III (November-December, 1965), 3-8.

93. Hosmer, Craig. "Whatever Happened to Federal Funds?" Physics Today, XXI (June, 1968), 23-27.

94. Hull, E.W. Seabrook. "The Political Action," International Science and Technology, Number 64 (April, 1967), 763-764.

95. Hutchinson, Eric. "Politics and Higher Education," Science, CXLVI (November 27, 1964), 1139-1142.

96. Imai, Ryukichi. "~~Japan and~~ the World of SALT," Bulletin of the Atomic Scientists, XXVII (December, 1971), 13-16.

97. Inglis, David R. "Nuclear Energy and the Malthusian Dilemma," Bulletin of the Atomic Scientists, XXVII (February, 1971), 14-18.

98. Jensen, Arthur R. "Race and Genetics of Intelligence: A Reply to Lewontin," Bulletin of the Atomic Scientists, XXVI (May, 1970), 17-23.

99. Jensen, Edwood V. "The Science of Science," Perspectives in Biology and Medicine, XXII (Winter, 1969), 274-289.

100. Jordan, Walter H. "Nuclear Energy: Benefits versus Risks," Physics Today, XXIII (May, 1970), 32-38.

101. Jost, Alfred. "Reproduction (II): Human Control of Reproductive Processes," Impact, XX (October-December, 1970), 267-278.

102. Kantrowitz, Arthur. "Proposal for an Institution for Scientific Judgment," Science, CLVI (May 12, 1967), 763-764.

103. Karber, Phillip A. "The Nixon Policy on CBW," Bulletin of the Atomic Scientists, XXVIII (January, 1972), 22-25; 27.

104. Kardos, Louis T. "A New Prospect," Environment, XII (March, 1970), 10-21; 27.

105. Kash, Don E. "Forces Affecting Science Policy," Bulletin of the Atomic Scientists, XXV (April, 1969), 10-15.

106. ________. "Is Good Science Good Politics?" Bulletin of the Atomic Scientists, XXI (March, 1965), 34-36.

107. ________. "The Tyranny of Realism," Bulletin of the Atomic Scientists, XXIII (February, 1967), 16-20.

108. Kass, Leon R. "The New Biology: What Price Relieving Man's Estate?" Science, CLXXIV (November 19, 1971), 779-787.

109. Kerr, James R. "Congress and Space: Overview or Oversight?" Public Administration Review, XXV (September, 1965), 185-192.

110. King, Alexander. "Science Policy, Economic Growth, and the Quality of Life," Science Policy News, II (July, 1970), 1-6.

111. Kinzel, Augustus B. "The Engineer Goes to Washington," International Science and Technology, Number 42 (June, 1965), 49-52.

112. Kistiakowsky, George B. "National Policy for Science," Chemical and Engineering News, XL (January 22, 1962), 120-124.

113. Klass, Philip J. "Independent Research Due Closer Scrutiny," Aviation Week and Space Technology, XCII (March 16, 1970), 21-22.

114. ________. "Recon Satellite Assumes Dual Role," Aviation Week and Space Technology, XCV (August 30, 1971), 12-13.

115. Kofmehl, Kenneth. "COSPUP, Congress, and Scientific Advice," Journal of Politics, XXVIII (February, 1966), 100-120.

116. Kvam, Roger A. "COMSAT: The Inevitable Anomaly," in Knowledge and Power: Essays on Science and Government, ed. by Sanford A. Lakoff. New York: Free Press, 1966, 271-292.

117. Lakoff, Sanford A. "The Scientific Establishment and American Pluralism," in Knowledge and Power: Essays on Science and Government, ed. by Sanford A. Lakoff. New York: Free Press, 1966, 377-392.

118. Langer, Elinor. "Chemical and Biological Warfare (II): The Weapons and the Policies," Science, CLV (January 20, 1967), 299-303.

119. Langrish, John. "Does Industry Need Science?" Science Journal, Va (December, 1969), 81-84.

120. Leavitt, Thomas W. "The Future of the Space Program...Riding on the Reusable Shuttle," Air Force Magazine, LIII (December, 1970), 58-61.

121. Lederberg, Joshua. "Biological Warfare: A Global Threat," American Scientists, LXIX (March-April, 1971), 195-197.

122. Lederberg, Joshua. "A Freeze on Missile Testing," Bulletin of the Atomic Scientists, XXVII (March, 1971), 4-6; 43.

123. Leich, Harold H. "Scientists and Engineers in a Civil Service System," Public Personnel Review, XXVI (January, 1965), 35-39.

124. Leiserson, Avery. "Scientists and the Policy Process," American Political Science Review, LIX (June, 1965), 408-416.

125. Leitenberg, Milton. "The Present State of the World's Arms Race," Bulletin of the Atomic Scientists, XXVIII (January, 1972), 15-21.

126. Lewontin, Richard C. "Further Remarks on Race and the Genetics of Intelligence," Bulletin of the Atomic Scientists, XXVI (May, 1970), 23-25.

127. Lindveit, Earl W. "Science, Education, and Politics," Educational Record, XLV (Winter, 1964), 41-48.

128. Long, Thomas D. "The Government of Science: A Comparative Approach," Science Studies, I (October, 1971), 263-286.

129. Low, Ian. "Science and Weaponry," New Scientists, XXXVII (February 29, 1968), 464-465.

130. Lowe, George E. "Congress and Scientific Advice," Bulletin of the Atomic Scientists, XXI (December, 1965), 39-42.

131. Lundberg, George A. "The Senate Ponders Social Science," Scientific Monthly, LXIV (May, 1947), 397-411.

132. MacArthur, Donald M. "Current Emphasis on the Department of Defense's Social and Behavioral Sciences Program," American Psychologist, XXIII (February, 1968), 104-107.

133. McCaull, Julian. "The Black Tide," Environment, XI (November, 1969), 2-16.

134. MacDonald, Gordon J.F. "Science and Politics of Rainmaking," Bulletin of the Atomic Scientists, XXIV (October, 1968), 8-14.

135. McElheny, Victor K. "Can Scientific Unpredictability Become Public Policy?" Technology Review, LXXI (December, 1968), 10-11.

136. Macinko, John. "The Tailpipe Problem," Environment, XII (June, 1970), 6-13.

137. Macy, John W., Jr. "The Scientist in the Federal Service," Science, CXLVIII (April, 1965), 51-54.

138. Magruder, William M. "SST: Lessons in All That Pain," Astronautics and Aeronautics, IX (July, 1971), 16-18.

139. Mainzer, Lewis. "The Scientist as Public Administrator," Western Political Quarterly, XVI (December, 1965), 814-829.

140. Malik, Rex. "The Data Bank Society: Can We Cope?" New Scientist and Science Journal, XLIX (March 4, 1971), 497-499.

141. Mandelbaum, Leonard. "Apollo: How the United States Decided to Go to the Moon," Science, CLVIII (February 14, 1969), 649-654.

142. Mann, Thaddens. "Reproduction (1): Sex, Drugs and Ethics," Impact of Science on Society, XX (October-December, 1970), 255-265.

143. Mascall, Eric L. "A Theologian's View of Science," New Scientist and Science Journal, LI (August 19, 1971), 417-419.

144. Massey, Harrie. "Evolution of a Policy for Science," New Scientist, XXXII (November 24, 1966), 428-429.

145. Mather, Kirtley. "The Common Ground of Science and Politics," Science, CXVII (February 20, 1953), 169-174.

146. Mead, Margaret. "Public Policy and Behavioral Science," Bulletin of the Atomic Scientists, XXV (December, 1969), 8-10.

147. Mesthene, Emmanuel G. "Can Only Scientists Make Government Science Policy?" Science, CXLV (July 17, 1964), 237-245.

148. ______. "The Impact of Science on Public Policy," Public Administration Review, XXVII (June, 1967), 97-104.

149. Moler, Murray. "Emphasis on Protection Will Make Big Alaskan Pipeline Better, Safer," Congressional Record, CXVII (September 23, 1971), S14918-S14919.

150. Mondale, Walter F. "The Implications of Biomedical Research and Technology," Congressional Record, CXVII (April 29, 1971), S5912-S5929.

151. Morse, John F. "The Federal Government and Higher Education: General and Specific Concerns in the Years Ahead," Educational Record, XLVII (Fall, 1966), 429-438.

152. Murcier, Alain. "Brains for Sale," Bulletin of the Atomic Scientists, XXIV (March, 1968), 38-4[illegible].

153. Nader, Claire. "The Technical Expert in a Democracy," Bulletin of the Atomic Scientists, XXII (May, 1966), 28-30.

154. Nagle, James J. "Genetic Engineering," Bulletin of the Atomic Scientists, XXVII (December, 1971), 43-45.

155. Nelson, Bryce. "HEW Blacklisting Issue Ignites Again," Science, CLXVI (October 17, 1969), 357.

156. ________. "HEW Security Checks Said to Bar Qualified Applicants to PHS," Science, CLXV (July 18, 1969), 269-271.

157. Nelson, Gaylord. "Herbicides and the Geneva Protocol," Congressional Record, CXVII (March 24, 1971), S3797-S3800.

158. Nichols, R.W. "The Coming SALTing of Defense R & D," Innovation, XXVI (November, 1971), 46-57.

159. Niering, William A. "Effects of Pesticides," AIBS Bulletin (BioScience), XVIII (September, 1968), 869-875.

160. Novick, Sheldon. "A Mile from Times Square," Environment, XI (January-February, 1969), 10-15;39.

161. ________. "A New Pollution Problem," Environment, XI (May, 1969), 2-9.

162. Orlans, Harold. "Developments in Federal Policy toward University Research," Science, CLV (February 10, 1967), 665-668.

163. ________. "Social Science Research Policies in the United States," Minerva, IX (January, 1971), 7-31.

164. Ossowska, Maria and Stanislaw Ossowski. "The Science of Science," Minerva, III (Autumn, 1964), 72-82.

165. Page, Howard E. "University Science Development One Hundred Million Dollars Later," Educational Record, XLIX (Summer, 1968), 250-256.

166. Pauling, Linus. "Genetic and Somatic Effects of High-Energy Radiation," Bulletin of the Atomic Scientists, XXVI (September, 1970), 3-5.

167. Perl, Martin L. "SALT and Its Illusion," Bulletin of the Atomic Scientists, XXVII (December, 1971), 7-12.

168. Peter, William G., III. "Ethical Perspectives in the Use of Genetic Knowledge," BioScience, XXI (November 15, 1971), 1133-1137.

169. Peterle, Tony J. "Pyramiding Damage," Environment, XI (July-August, 1969), 34-40.

170. Peterson, Eugene K. "The Atmosphere: A Clouded Horizon," Environment, XII (April, 1970), 32-39.

171. Pitzer, Kenneth S. "Science and Society: Some Policy Changes Are Needed," Science, CLXXII (April 16, 1971), 223-226.

172. Possony, Stefan and Jerry Pournelle. "The Technological War," Congressional Record, CXVII (May 25, 1971), E5012-E5016.

173. Price, Derek J. de Solla. "The Scientific Foundations of Science Policy," Nature, CCVI (April 17, 1965), 233-238.

174. Price, Don K. "The Established Dissenters," Daedalus, XCIV (Winter, 1965), 84-116.

175. ________. "Purists and Politicians," Science, CLXIII (January 3, 1969), 25-31.

176. ________. "Science at a Policy Crossroads," Technology Review, LXXIII (April, 1971), 31-37.

177. ________. "The Scientific Establishment," Science, CXXXVI (June 29, 1962), 1099-1106.

178. Price, Don K., J. Stefan Dupree, and W. Eric Gustafson. "Current Trends in Science Policy in the United States," Impact of Science on Society, X (Number 3, 1960), 187-211.

179. Psacharopoulos, George. "On Some Positive Aspects of the Economics of the Brain Drain," Minerva, IX (April, 1971), 231-241.

180. Pugwash Continuing Committee. "SALT and International Security," Bulletin of the Atomic Scientists, XXVII (December, 1971), 17-19.

181. Rabinowitch, Eugene. "Decision Making in the Scientific Age," in The Scientific Revolution: Challenge and Promise, ed. by Gerald W. Elbers and Paul Duncan. Washington, D.C.: Public Affairs Press, 1959, 23-29.

182. Radford, Edward P., et al. "Statement of Concern," Environment, XI (September, 1969), 18-27.

183. Rathjens, George W. "The ABC of ABMs," Bulletin of the Atomic Scientists, XXVII (March, 1971), 14-16.

184. Rettig, Richard A. "Science, Technology, and Public Policy," World Politics, XXIII (January, 1971), 273-293.

185. Reuss, Henry S. "The Garwin SST Report: A $425 Million Misunderstanding," Congressional Record, CXVII (September 16, 1971), H8553-H8558.

186. Risebrough, Robert and Virginia Brodine. "More Letters in the Wind," Environment, XII (January-February, 1970), 16-26.

187. Rose, Michael. "The Social Control of Computerized Data-Banking," Technology and Society, VI (March, 1971), 104-107.

188. Russell, R. Scott. "Contamination of the Biosphere with Radioactivity," Biological Conservation, II (October, 1969), 2-9.

189. Salomon, Jean-Jacques. "A Science Policy for the 1970's," OECD Observer, LIII (August, 1971), 3-9.

190. Samuelson, Robert J. "The SST and Government: Critics Shout into a Vacuum," Science, CLVII (September 8, 1967), 1146-1151.

191. Sapolsky, Harvey M. "Science, Voters, and the Fluoridation Controversy," Science, CLXII (October 25, 1968), 427-433.

192. Sawyer, Jack and Howard Schechter. "Computers, Privacy, and the National Data Center: The Responsibility of Social Scientists," American Psychologist, XXIII (November, 1968), 810-818.

193. Sayre, Wallace S. "Scientists and American Science Policy," Science, CXXXIII (March 24, 1961), 859-864.

194. Scarr-Salapatek, Sandra. "Race, Social Class, and IQ," Science, CLXXIV (December 24, 1971), 1285-1295.

195. Schilling, Warner R. "Scientists, Foreign Policy, and Politics," American Political Science Review, LVI (June, 1962), 287-300.

196. Science. "Secrecy and Dissemination in Science and Technology," Science, CLXIII (February 21, 1969), 787-790.

197. Science Forum. "Who Should Make Science Policy?" and "The Lamontagne Report: Science Policy in Canada is a Legacy of Failures," Science Forum, IV (February, 1971), 2-4.

198. Scientific American. "Unreordered Priority," Scientific American, CCXXV (July, 1971), 42-43.

199. Seitz, Frederick. "The Governmental Science Administrator," Physics Today, XIV (August, 1961), 36-38.

200. Shaffer, Helen B. "Jumbo Jets: New Travel Era," Editorial Research Reports, Number 11 (September 10, 1969), 669-688.

201. Shannon, James A. "Science and Federal Programs: The Continuing Dialogue," Science, CXLIV (May 22, 1964), 976-978.

202. Shapley, Deborah. "Plutonium: Reactor Proliferation Threatens a Nuclear Black Market," Science, CLXXII (April 9, 1971), 143-146.

203. Shea, Kevin P. "Unwanted Harvest," Environment, XI (September, 1969), 12-16; 28-31.

204. Sherwin, Chalmers W. "The Management of Science in the Public Interest," Bulletin of the Atomic Scientists, XX (June, 1964), 9-12.

205. Shils, Edward A., ed. "American Visa Policy and Foreign Scientists," Bulletin of the Atomic Scientists, VIII (October, 1952), special issue.

206. ______. "Scientists, Administrators, and Politicians: The Report of the Riehlman Committee," Bulletin of the Atomic Scientists, X (December, 1954), 371-374.

207. Shipman, George A. "When Is Research Research?" Public Administration Review, XXVIII (November-December, 1968), 556-558.

208. Sinsheimer, Robert L. "Genetic Engineering: The Modification of Men," Impact, XX (October-December, 1970), 279-291.

209. Skolnikoff, Eugene B. "Scientific Advice in the State Department," Science, CLIV (November 25, 1966), 980-985.

210. Smith, Bernard. "Ideal Urban Transit," Astronautics and Aeronautics, VI (September, 1968), 68-71.

211. Smith, Bruce. "The Non-Profit Research Corporations in the U.S.A.," New Scientist, XXX (June 30, 1966), 858-860.

212. Snow, Charles P. "Government, Science, and Public Policy," Science, CLI (February 11, 1966), 650-653.

213. Staley, Eugene. "Scientific Developments and Foreign Policy," Bulletin of the Atomic Scientists, XVI (January, 1960), 7-13.

214. Stone, Michael G. and Malcolm Warner. "Politics, Privacy, and Computers," Political Quarterly, XL (July-September, 1969), 256-267.

215. Stratton, Julius A. "Science and the Process of Management," Research Management, VII (March, 1964), 79-90.

216. Swihart, John M. "Our SST and Economics," Astronautics and Aeronautics, VIII (April, 1970), 30-51.

217. Tamplin, Arthur R. and John W. Gofman. "The Radiation Effects Controversy," Bulletin of the Atomic Scientists, XXVI (September, 1970), 2; 5-8.

218. Thompson, Theos J. and William R. Bibb. "Response to Gofman and Tamplin: The AEC Position," Bulletin of the Atomic Scientists, XXVI (September, 1970), 9-12; 48.

219. Truman, David B. "The Social Sciences and Public Policy," Science, CLX (May 3, 1968), 508-512.

220. van den Bosch, Robert. "Pesticides: Prescribing for the Ecosystem," Environment, XII (April, 1970), 20-25.

221. Van Doren, Charles N. "U.N. Involvement in Disarmament: The Case of the Non-Proliferation Treaty," American Journal of International Law, LXIV (September, 1970), 191-194.

222. Viorst, Milton. "The Political Good Fortune of Medical Research," Science, CXLIV (April 17, 1964), 267-270.

223. Vohra, Hans R. "Ministry of Science--U.S. Style," Bulletin of the Atomic Scientists, XXVII (January, 1971), 29-32.

224. von Braun, Werner. "Man and Space Exploration," Congressional Record, CXVII (February 24, 1971), E1111-E1114.

225. Wade, Nicholas. "Cancer Politics: NIH Backers Mount Late Defense in House," Science, CLXXIV (October 8, 1971), 127-131.

226. ________. "Decision on 2, 4, 5-T: Leaked Reports Compel Regulatory Responsibility," Science, CLXXIII (August 13, 1971), 610-615.

227. Walker, Eric A. "National Science Board: Its Place in National Policy," Science, CLVI (April 28, 1967), 474-477.

228. Walsh, John. "Antipoverty R & D: Chicago Debacle Suggests Pitfalls Facing OEO," Science, CLXV (September 19, 1969), 1243-1245.

229. Watkins, Harold D. "SST Faces Congressional Hurdle," Aviation Week and Space Technology, XCI (September 29, 1969), 16-18.

230. Webb, James E. "Education in the Space Age," Educational Record, XLV (Winter, 1964), 33-40.

231. Weil, Andrew T., Norman E. Zinberg, and Judith M. Nelsen. "Clinical Psychological Effects of Marijuana in Man," Science, CLXII (December 13, 1968), 1234-1242.

232. Weinberg, Alvin M. "Impact of Large-Scale Science on the United States," Science, CXXXIV (July 21, 1961), 161-164.

233. Weinberg, Alvin M. "Nuclear Energy and the Environment," Bulletin of the Atomic Scientists, XXVI (June, 1970), 69-74.

234. ________. "Scientific Choice and the Scientific Muckrakers: Review Article," Minerva, VII (Autumn-Winter, 1968-69), 52-63.

235. Wendland, Wayne M. and Reid A. Bryson. "Atmospheric Dustiness, Man, and Climatic Change," Biological Conservation, II (January, 1970), 125-128.

236. Wheeler, Harvey. "A Center Report: Man's Doing and Undoing," Center Magazine, II (November, 1969), 32-49.

237. Wiesner, Jerome B. "Hope for GCD?" Bulletin of the Atomic Scientists, XXIV (January, 1968), 10-15.

238. Wilson, Richard. "Politics of Nuclear Power in the United States," Nature, CCXXXIII (October 15, 1971), 453-454.

239. Woodwell, George M. "Radioactivity and Fallout: The Model Pollution," AIBS Bulletin (BioScience), XIX (October, 1969), 884-886.

240. Worsnop, Richard L. "Urban Transit Crush," Editorial Research Reports (July 8, 1970), 507-526.

241. Wurster, Charles F., Jr. "Chlorinated Hydrocarbon Insecticides and the World Ecosystem," Biological Conservation, I (January, 1969), 123-129.

General References: Books

242. Aerospace Industries Association of America, Inc. Aerospace and the U.S. Economy: Its Role, Contributions, and Critical Problems. Washington, D.C.: Aerospace Industries Association of America, 1971, 68.

243. ________. The Supersonic Transport, Fantasy and Fact. Washington, D.C.: Aerospace Industries Association of America, 1971, 9.

244. American Foundation for Continuing Education at Syracuse University. Science and Public Policy, ed. by Louise B. Young and William J. Trainor. Dobbs Ferry, New York: Oceana, 1971, 626.

245. Anderson, Walt, ed. Politics and Environment: A Reader to Ecological Crisis. Pacific Palisades, California: Goodyear, 1970, 362.

246. Armacost, Michael H. The Politics of Weapons Innovation: The Thor-Jupiter Controversy. New York: Columbia University Press, 1969, 304.

247. Augenstein, B.W. Policy Analysis in the National Space Program. Santa Monica, California: RAND Corporation, 1969, 100.

248. Bader, William B. The United States and the Spread of Nuclear Weapons. New York: Pegasus, 1968, 176.

249. Baird, J., et al. Some Major Impacts of the National Space Program--Final Report of Pilot Study. Stanford, California: Stanford Research Institute, 1968, 48. (N69 12564)

250. Barber, Bernard. Drugs and Society. New York: Russell Sage Foundation, 1967, 212.

251. Barber, Richard J. The Politics of Research. Washington, D.C.: Public Affairs Press, 1966, 167.

252. Barnaby, Charles F., ed. Preventing the Spread of Nuclear Weapons. London: Souvenir Press, 1969, 374.

253. Barnet, Richard J. The Economy of Death. New York: Atheneum, 1969, 201.

254. Bass, Lawrence W. and Bruce S. Old, eds. Formulation of Research Policies. Washington, D.C.: American Association for the Advancement of Science, 1967, 210.

255. Bauer, Raymond A. and Kenneth Gergen, eds. The Study of Policy Formation. New York: Free Press, 1968, 392.

256. Baumgartner, John S. The Lonely Warriors: Case for the Military-Industrial Complex. Los Angeles: Nash, 1970, 237.

257. Beals, Ralph L. Politics of Social Research: An Inquiry into the Ethics and Responsibilities of Social Scientists. Chicago: Aldine, 1969, 228.

258. Beecher, Henry K. Research and the Individual: Human Studies. Boston: Little, Brown, 1970, 358.

259. Beecher, Henry K., et al. Ethical Aspects of Experimentation with Human Subjects. Brookline, Massachusetts: American Academy of Arts and Sciences, 1969, 390.

260. Blackall, T.E. Concorde: The Study, the Facts, and the Figures. Henley-on-Thames, England: Foulis, 1969, 108.

261. Blake, John B., ed. Safeguarding the Public: Historical Aspects of Medicinal Drug Control. Baltimore, Maryland: Johns Hopkins Press, 1970, 200.

262. Boulding, Kenneth E., et al. National Priorities: Military, Economic, and Social. Washington, D.C.: Public Affairs Press, 1969, 176.

263. Brim, Orville G., Jr., et al. The Dying Patient. New York: Russell Sage Foundation, 1970, 390.

264. Brodie, Bernard. The American Scientific Strategists. Santa Monica, California: RAND Corporation, 1964, 53.

265. Brown, Frederic J. Chemical Warfare: A Study in Restraints. Princeton, New Jersey: Princeton University Press, 1968, 355.

266. Buchan, Alastair, ed. A World of Nuclear Powers? Englewood Cliffs, New Jersey: Prentice-Hall, 1966, 176.

267. Byatt, Ian C. and Adrian V. Cohen. An Attempt to Quantify the Economic Benefits of Scientific Research. London: Her Majesty's Stationery Office, 1969, 25.

268. Carson, Rachel. Silent Spring. Boston: Houghton-Mifflin, 1962, 368.

269. Charlesworth, James C. and Alfred J. Eggers, eds. Harmonizing Technological Developments and Social Policy in America. Philadelphia: American Academy of Political and Social Science, 1970, 247.

270. Chayes, Abram and Jerome B. Wiesner, eds. ABM: An Evaluation of the Decision to Deploy an Antiballistic Missile System. New York: Harper and Row, 1969, 282.

271. Clarke, Robin. The Science of War and Peace. London: Cape, 1971, 348.

272. Connery, Robert H., et al. The Politics of Mental Health: Organizing Community Mental Health in Metropolitan Areas. New York: Columbia University Press, 1968, 595.

273. Cookson, John and Judith Nottingham. A Survey of Chemical and Biological Warfare. London: Sheed and Ward, 1969, 376.

274. Cooley, Richard A. and Geoffrey Wandesforde-Smith, eds. Congress and the Environment. Seattle: University of Washington Press, 1970, 277.

275. Cox, Donald W. America's New Policy Makers: The Scientists' Rise to Power. Philadelphia: Chilton, 1964, 298.

276. Curtis, Charles P. The Oppenheimer Case: The Trial of a Security System. New York: Simon and Schuster, 1955, 281.

277. Davies, J. Clarence, III. The Politics of Pollution. New York: Pegasus, 1970, 231.

278. Davis, Nuel P. Lawrence and Oppenheimer. New York: Simon and Schuster, 1968, 384.

279. de Bold, Richard C. and Russell C. Leaf, eds. LSD, Man, and Society. Middletown, Connecticut: Wesleyan University Press, 1967, 2[illegible].

280. Delgado, Jose. Physical Control of the Mind: Toward A Psychocivilized Society. New York: Harper and Row, 1969, 280.

281. Dencik, Lars, ed. International Symposium on Scientific Research and Politics, Lund University, 1968. Lund, Sweden: Student-litteratur, 1969, 263.

282. Dobzhansky, Theodosius. Heredity and the Nature of Man. New York: Harcourt, Brace and World, 1964, 179.

283. Dougherty, James E. Arms Control and Disarmament, The Critical Issues. Washington, D.C.: Center for Strategic Studies, Georgetown University, 1966, 92.

284. Downing, Alvin B., ed. Euthanasia and the Right to Death: The Case for Voluntary Euthanasia. New York: Humanities Press, 1970, 206.

285. Dupree, J. Stefan and Sanford A. Lakoff. Science and the Nation: Policy and Politics. Englewood Cliffs, New Jersey: Prentice-Hall, 1962, 181.

286. Ebling, Francis J., ed. Biology and Ethics. New York: Academic Press, 1969, 145.

287. Ehrlich, Paul R. The Population Bomb. New York: Ballantine, 1968, 223.

288. Etzioni, Amitai. The Moon-Doggle: Domestic and International Implications of the Space Race. Garden City, New York: Doubleday, 1964, 198.

289. Farrington, Benjamin. Science and Politics in the Ancient World. London: Allen and Unwin, 1939, 243.

290. Feld, Bernard T., Thomas Greenwood, George W. Rathjens, and Samuel Weinberg, eds. The Impact of New Technologies on the Arms Race. Cambridge, Massachusetts: M.I.T. Press, 1971, 379.

291. Feller, Ivan, ed. The Application of Science and Technology to Public Programs. University Park: Center for the Study of Science Policy, Institute for Research on Human Resources, Pennsylvania State University, 1971, 521.

292. Fermi, Laura. Illustrious Immigrants: The Intellectual Migration from Europe, 1930-1941. Chicago: University of Chicago Press, 1968, 440.

293. Fleagle, Robert G., ed. Weather Modification: Science and Public Policy. Seattle and London: University of Washington Press, 1969, 147.

294. Fleming, Donald and Bernard Bailyn, eds. The Intellectual Migration: Europe and America, 1930-1960. Cambridge, Massachusetts: Harvard University Press, 1969, 748.

295. Forney, Robert B. and Francis Hughes. Combined Effects of Alcohol and Other Drugs. Springfield, Illinois: Thomas, 1968, 124.

296. Fuqua, Paul S., ed. Nimlo Seminar on Urban Violence and Environmental Problems, Washington, D.C., 1970. Washington, D.C.: National Institute of Municipal Law Officers, 1970, 194.

297. Gilpin, Robert. American Scientists and Nuclear Weapons Policy. Princeton, New Jersey: Princeton University Press, 1962, 352.

298. Gilpin, Robert and Christopher Wright, eds. Scientists and National Policy-Making. New York: Columbia University Press, 1964, 408.

299. Green, Harold P. and Alan Rosenthal. Government of the Atom: The Integration of Powers. New York: Atherton Press, 1963, 281.

300. Greenberg, Daniel S. The Politics of Pure Science. New York: New American Library, 1968, 303.

301. Haberer, Joseph. Politics and the Community of Science. New York: Van Nostrand Reinhold, 1969, 337.

302. Hardin, Garrett, ed. Population, Evolution, and Birth Control: A Collage of Controversial Readings. Second Edition. San Francisco: Freeman, 1969, 386.

303. Harvard University Program on Technology and Society. Technology and the Polity. Research Review No. 4. Cambridge, Massachusetts: Harvard University Program on Technology and Society, 1969, 53.

304. Haskins, Caryl P. The Scientific Revolution and World Politics. Published for the Council on Foreign Relations, New York: Harper and Row, 1964, 115.

305. Holst, Johan J. and William Schneider, Jr., eds. Why Arm? Policy Issues in the Missile Defense Controversy. New York: Pergamon Press, 1969, 321.

306. Horowitz, Irving, ed. The Rise and Fall of Project Camelot. Cambridge, Massachusetts: M.I.T. Press, 1967, 385.

307. India. Council for Scientific and Industrial Research. Research Survey and Planning Organization. Index to Literature on Science of Science. New Delhi: Council for Scientific and Industrial Research. Surveys published bi-monthly.

308. Jacobson, Harold K. and Eric Stein. Diplomats, Scientists, and Politicians: The United States and the Nuclear Test Ban Negotiations. Ann Arbor: University of Michigan Press, 1966, 548.

309. Kash, Don E. The Politics of Space Cooperation. Lafayette, Indiana: Purdue University Studies, 1967, 137.

310. Knorr, Klaus and Oscar Morganstern. Science and Defense: Some Critical Thoughts on Military Research and Development. Princeton, New Jersey: Wilson School of Public and International Affairs, Princeton University, 1965, 58.

311. Komons, Nick A. Science and the Air Force: A History of the Air Force Office of Scientific Research. Arlington, Virginia: Historical Division, Office of Information, Office of Aerospace Research, 1966, 175.

312. Kuttner, Robert E., ed. Race and Modern Science: A Collection of Essays by Biologists, Anthropologists, Sociologists, and Psychologists. New York: Social Science Press, 1967, 427.

313. Lakoff, Sanford A., ed. Knowledge and Power: Essays on Science and Government. New York: Free Press; London: Collier-Macmillan, 1966, 502.

314. Lambright, Walter H. Public Administration and Science and Technology. Syracuse, New York: Syracuse University, 1969, 28.

315. Lapp, Ralph E. Arms Beyond Doubt: The Tyranny of Weapons Technology. New York: Cowles, 1970, 210.

316. ________. The New Priesthood. New York: Harper and Row, 1965, 244.

317. ________. The Weapons Culture. New York: Norton, 1968, 230.

318. Lecht, Leonard A. Goals, Priorities, and Dollars: The Next Decade. New York: Free Press, 1966, 365.

319. Lindveit, Earl W. Scientists in Government. Washington, D.C.: Public Affairs Press, 1960, 85.

320. Logsdon, John M. The Decision to Go to the Moon: Project Apollo and the National Interest. Cambridge, Massachusetts: M.I.T. Press, 1970, 188.

321. Lauria, Donald B. The Drug Scene. New York: McGraw-Hill, 1968, 214.

322. Lyons, Gene M. The Uneasy Partnership: Social Science and the Federal Government in the Twentieth Century. New York: Russell Sage Foundation, 1969, 394.

323. McCamy, James L. Science and Public Administration. Birmingham: University of Alabama Press, 1960, 218.

324. McClintock, Michael. Environmental Effects of Weapons Technology. New York: Scientists' Institute for Public Information, 1970, 32.

325. Major, John. The Oppenheimer Hearing. London: Batsford, 1971, 336.

326. Manning, Thomas G. Government in Science: The U.S. Geological Survey, 1867-1894. Lexington: University of Kentucky Press, 1967, 257.

327. Mansfield, Edwin. The Economics of Technological Change. New York: Norton, 1968, 224.

328. Mansfield, Melvin, ed. Defense, Science, and Public Policy. New York: Norton, 1968, 224.

329. Meynaud, Jean. Technocracy. New York: Free Press, 1969, 315.

330. Michelmore, Peter. The Swift Years: The Robert Oppenheimer Story. New York: Dodd, Mead, 1969, 273.

331. Moore, Ernest G. The Agricultural Research Service. New York: Praeger, 1967, 244.

332. Moss, Norman. Men Who Play God: The Story of the H-Bomb and How the World Came to Live With It. New York: Harper and Row, 1968, 352.

333. National Academy of Sciences. The Behavioral Sciences and the Federal Government. Washington, D.C.: National Academy of Sciences, 1968, 107. (Publication 1680)

334. ________. Committee on Research in the Life Sciences, Committee on Science and Public Policy. The Life Sciences. Washington, D.C.: National Academy of Sciences, 1970, 525.

335. ________. National Academy of Engineering. The Impact of Science and Technology on Regional Economic Development. Washington, D.C.: National Academy of Engineering, 1969, 112. (Publication 1731)

336. National Academy of Sciences - National Research Council. Space Science Board. Lunar Exploration: Strategy for Research 1969-1975. Washington, D.C.: National Academy of Sciences, 1969, 40.

337. ______. Space Science Board. Priorities for Space Research, 1971-1980. Washington, D.C.: National Academy of Sciences, 1971, 148.

338. ______. Space Science Board. United States Space Science Program. Report to COSPAR, Fourteenth Meeting, Seattle, Washington, June, 1971. Washington, D.C.: National Academy of Sciences, 1971, 230.

339. National Aeronautics and Space Administration. America's Next Decades in Space: A Report for the Space Task Group. Washington, D.C.: NASA, 1969, 84.

340. ______. Office of Technology Utilization. A Study of NASA University Programs. Prepared by the Task Force to Assess NASA University Programs. Washington, D.C.: NASA, 1968, 79. (NASA SP-185)

341. National Goals Research Staff. Toward Balanced Growth: Quantity with Quality. Washington, D.C.: U.S. Government Printing Office, 1970, 223.

342. National Science Foundation. Weather Modification. Tenth Annual Report, 1968. Washington, D.C.: U.S. Government Printing Office, 1969, 141. (NSF 69-18)

343. ______. National Science Board. The Physical Sciences. Washington, D.C.: U.S. Government Printing Office, 1970, 62.

344. ______. National Science Board. Knowledge into Action: Improving the Nation's Use of the Social Sciences. Report of the Special Commission on the Social Sciences. Washington, D.C.: U.S. Government Printing Office, 1969, 95. (NSF 69-3)

345. Nelson, William R., ed. The Politics of Science: Readings in Science, Technology, and Government. New York: Oxford University Press, 1968, 495.

346. Niblett, Clarence B. Digital Information and the Privacy Problem. Paris: Organization for Economic Cooperation and Development, 1971, 58.

347. Nieburg, Harold L. Nuclear Secrecy and Foreign Policy. Washington, D.C.: Public Affairs Press, 1964, 255.

348. Organization for Economic Cooperation and Development. Information for a Changing Society: Some Policy Considerations. Paris: OECD, 1971, 48.

349. ________. Reviews of National Science Policy: United States. Paris: OECD, 1968, 622.

350. ________. Science, Growth, and Society: A New Perspective. Report on the Secretary-General's Ad Hoc Group on New Concepts of Science Policy. Washington, D.C.: OECD, 1971, 113.

351. ________. Technological Forecasting in Perspective (A Framework for Technological Forecasting, Its Techniques and Organization: A Description of Activities and Annotated Bibliography). By Erich Jantsch. Paris: OECD, 1966, 493.

352. Orland, Harold. Contracting for Atoms: A Study of Public Issues Posed by the Atomic Energy Commission's Contracting for Research, Development, and Managerial Services. Washington, D.C.: Brookings Institution, 1967, 242.

353. Orland, Harold, ed. Science Policy and the University. Washington, D.C.: Brookings Institution, 1968, 352.

354. Osborn, Frederick. The Future of Human Heredity: An Introduction to Eugenics in Modern Society. New York: Weybright and Talley, 1968, 133.

355. Pappworth, Murice H. Human Guinea Pigs: Experimentation on Man. Boston: Beacon Press, 1967, 228.

356. Penick, James L., Jr., Carroll W. Pursell, Jr., Morgan B. Sherwood, and Donald C. Swain, eds. The Politics of American Science: 1939 to The Present. Chicago: Rand McNally, 1965, 287.

357. Pollard, William G. Atomic Energy and Southern Science. Oak Ridge, Tennessee: Oak Ridge Associated Universities, 1966, 140.

358. Price, Don K. Government and Science: Their Dynamic Relation in American Democracy. New York: New York University Press, 1954, 203.

359. Price, Don K. The Scientific Estate. Cambridge, Massachusetts: Harvard University Press, 1965, 323.

360. Proxmire, William. Report from Wasteland: America's Military-Industrial Complex. New York: Praeger, 1970, 245.

361. Reagan, Michael D. Science and the Federal Patron. New York: Oxford University Press, 1969, 346.

362. Roos, Leslie L., Jr. The Politics of Ecosuicide. New York: Holt, Rinehart, and Winston, 1971, 404.

363. Rose, Steven, ed. C.B.W.: Chemical and Biological Warfare. London: Harrap, 1968, 209.

364. Rosenberg, Jerry M. The Death of Privacy. New York: Random House, 1969, 236.

365. Rosenfeld, Albert. The Second Genesis: The Coming Control of Life. Englewood Cliffs, New Jersey: Prentice-Hall, 1969, 327.

366. Russett, Bruce M. What Price Vigilance? The Burdens of National Defense. New Haven, Connecticut and London: Yale University Press, 1970, 261.

367. Schiff, Ashley L. Fire and Water: Scientific Heresy in the Forest Service. Cambridge, Massachusetts: Harvard University Press, 1962, 225.

368. Schooler, Dean. Science, Scientists, and Public Policy. New York: Free Press, 1971, 338.

369. Scoville, Herbert and Robert Osborn. Missing Madness. Boston: Houghton-Mifflin, 1970, 77.

370. Skolnikoff, Eugene B. Science, Technology, and American Foreign Policy. Cambridge, Massachusetts: M.I.T. Press, 1967, 330.

371. Smith, Alice K. A Peril and a Hope: The Scientists' Movement in America, 1945-1947. Chicago and London: University of Chicago Press, 1965, 591.

372. Smith, David E., ed. The New Social Drug: Cultural, Medical and Legal Perspectives on Marijuana. Englewood Cliffs, New Jersey: Prentice-Hall, 1970, 186.

373. Smith, Frank E. The Politics of Conservation. New York: Pantheon Books, 1966, 350.

374. Stern, Philip M. The Oppenheimer Case: Security on Trial. New York: Harper and Row, 1969, 591.

375. Suljak, Nedjelko D. Public Policymaking and Environmental Quality: An Annotated Interdisciplinary Bibliography. Davis: Institute of Governmental Affairs, University of California, 1971, 176.

376. Swihart, James M. The Promise of the Supersonics. New York: Technical Information Service, 1970, 7.

377. Taviss, Irene and Judith Koivumaki, eds. Implications of Biomedical Technology. Cambridge, Massachusetts: Program on Technology and Society, Harvard University, 1968, 53.

378. Taylor, Gordon R. The Biological Time-Bomb. London: Thames and Hudson; Cleveland, Ohio: World, 1968, 240.

379. United Nations Educational, Scientific and Cultural Organization. Manual for Surveying National Scientific and Technological Potential. Science Policy Studies and Documents, No. 15. Paris: UNESCO, 1970, 251.

380. U.S. Arms Control and Disarmament Agency. World Military Expenditures, 1970 [and related data for 120 countries]. Washington, D.C.: U.S. Government Printing Office, 1971, 37.

381. U.S. Atomic Energy Commission. Personnel Security Board. In the Matter of J. Robert Oppenheimer, Transcript of Hearing. Washington, D.C., April 12-May 6, 1954. Washington, D.C.: U.S. Government Printing Office, 1954, 992.

382. U.S. Commission on Population Growth and the American Future. Population Growth and America's Future: Interim Report to the President and Congress. Washington, D.C.: U.S. Government Printing Office, 1971, 49.

383. U.S. Congress. House. Committee on Appropriations. Subcommittee on the Department of Transportation and Related Agencies Appropriations. Department of Transportation and Related Agencies Appropriations for 1970. Part 3: Civil Supersonic Aircraft Development. Hearings before the Subcommittee to the 91st Congress, 1st Session, October 9, 1970. Washington, D.C.: U.S. Government Printing Office, 1969, 354.

384. U.S. Congress. House. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. Chemical-Biological Warfare: U.S. Policies and International Effects. Hearings before the Subcommittee to the 91st Congress, 1st Session, November 18-December 19, 1969. Washington, D.C.: U.S. Government Printing Office, 1970, 513.

385. ________. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. Chemical-Biological Warfare: U.S. Policies and International Effects. Report of the Subcommittee to the 91st Congress, 2nd Session, May 16, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 41.

386. ________. Committee on Foreign Affairs. Subcommittee on National Security Policy and Scientific Developments. Strategy and Science: Toward a National Security Policy for the 1970's. Hearings before the Subcommittee to the 91st Congress, 1st Session, March 11-26, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 283.

387. ________. Committee on Government Operations. Subcommittee on Executive and Legislative Reorganization on S. 2701 and Related House Bills. Establishing a Commission on Population Growth, and Related Matters. Hearings before the Subcommittee to the 91st Congress, 1st Session, November 19-20, 1969. Washington, D.C.: U.S. Government Printing Office, 1970, 102.

388. ________. Committee on Government Operations. Subcommittee on Invasion of Privacy. Privacy and the National Data Bank Concept. House Report 1842 of the Subcommittee to the 90th Congress, 2nd Session, August 2, 1968. Washington, D.C.: U.S. Government Printing Office, 1968, 34.

389. ________. Committee on Government Operations. Subcommittee on Intergovernmental Relations. Deficiencies in Administration of Federal Insecticide, Fungicide, and Rodenticide Act. Hearings before the Subcommittee to the 91st Congress, 1st Session, May 7 and June 24, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 310.

390. ________. Committee on Government Operations. Subcommittee on Research and Technical Programs. Conflicts between Federal Research Programs and the Nation's Goals for Higher Education. Hearings before the Subcommittee to the 89th Congress, 1st Session, June 14, 15, and 17, 1965. Washington, D.C.: U.S. Government Printing Office, 1965, 202.

391. U.S. Congress. House: Committee on Science and Astronautics. Subcommittee on Advanced Research and Technology. Issues and Directions for Aeronautical Research and Development. House Report 91-932 of the Subcommittee to the 91st Congress, 2nd Session, March 23, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 102.

392. ________. Committee on Science and Astronautics. Subcommittee on NASA Oversight. For the Benefit of All Mankind: A Survey of the Practical Returns from Space Investment. House Report 91-1673 of the Subcommittee to the 91st Congress, 2nd Session, December 7, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 61.

393. ________. Committee on Science and Astronautics. Subcommittee on NASA Oversight. Manned Space Flight: Present and Future. Staff Study prepared for the Subcommittee by James E. Wilson and Harold A. Gould, 91st Congress, 2nd Session, February 12, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 391.

394. ________. Committee on Science and Astronautics. Subcommittee on NASA Oversight. The National Space Program: Present and Future. Compilation of papers prepared by the Subcommittee and presented to the 91st Congress, 2nd Session, December 10, 1971. Washington, D.C.: U.S. Government Printing Office, 1972, 246.

395. ________. Committee on Science and Astronautics. Subcommittee on Science, Research and Development. Applied Science and Technological Progress. Prepared for the Subcommittee by the National Academy of Sciences, 90th Congress, 1st Session, May 25, 1967. Washington, D.C.: U.S. Government Printing Office, 1967, 434.

396. ________. Committee on Science and Astronautics. Subcommittee on Science, Research and Development. The National Science Foundation: Its Present and Future. House Report 1236 of the Subcommittee to the 89th Congress, 2nd Session, February, 1966. Washington, D.C.: U.S. Government Printing Office, 1966, 118.

397. U.S. Congress. Joint Economic Committee. Subcommittee on Economy in Government. Economic Analysis and the Efficiency of Government. Part. 4: Supersonic Transport Development. Hearings before the Subcommittee to the 91st Congress, 2nd Session, May 7-12, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 889-1030.

398. U.S. Congress. Joint Economic Committee. Subcommittee on Economy in Government. The Economy, Energy, and the Environment. Background Study prepared for the Subcommittee by the Environmental Policy Division, Legislative Reference Service, Library of Congress, 91st Congress, 2nd Session, September 1, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 131.

399. U.S. Congress. Senate. Treaty on the Nonproliferation of Nuclear Weapons. Senate Executive Report 91-1, Together with Supplemental Views, to Accompany Executive Document H to the 90th Congress, 2nd Session, March 6, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 21.

400. ________. Committee on Aeronautical and Space Sciences. Future NASA Space Programs. Hearings before the Committee to the 91st Congress, 1st Session, August 5, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 70.

401. ________. Committee on Aeronautical and Space Sciences. Space Program Benefits. Hearings before the Committee to the 91st Congress, 2nd Session, April 6, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 379.

402. ________. Committee on Commerce. Subcommittee on Aviation. United States Commercial Supersonic Aircraft Development Program. Hearings before the Subcommittee to the 88th Congress, 1st Session, October 16, 17, 21, 22, 23, 25, and 29, 1963. Washington, D.C.: U.S. Government Printing Office, 1963, 524.

403. ________. Committee on Foreign Relations. Subcommittee on Arms Control, International Law, and Organization. ABM, MIRV, SALT, and the Nuclear Arms Race. Hearings before the Subcommittee to the 91st Congress, 2nd Session, March 16–June 29, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 624.

404. ________. Committee on the Judiciary. Subcommittee on Constitutional Rights. Privacy, the Census, and Federal Questionnaires. Hearings before the Subcommittee to the 91st Congress, 1st Session, April 24–July 1, 1969. Washington, D.C.: U.S. Government Printing Office, 1970, 1085.

405. U.S. Congress. Senate. Committee on Labor and Public Welfare. Subcommittee on the National Science Foundation. Chemical and Biological Weapons, Some Possible Approaches for Lessening the Threat and Danger. Prepared for the Special Subcommittee by the Science Policy Research Division, Legislative Reference Service, Library of Congress, 91st Congress, 1st Session, May, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 64.

406. ________. Committee on Public Works. Some Environmental Implications of National Fuels Policies. Staff Report of the Committee to the 91st Congress, 2nd Session, December, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 68.

407. U.S. Council on Environmental Quality. Ocean Dumping: A National Policy Report to the President. Washington, D.C.: U.S. Government Printing Office, 1970, 45.

408. U.S. Department of Transportation. Recommendations for Northeast Corridor Transportation. Washington D.C.: U.S. Government Printing Office, 1971, 3 volumes.

409. U.S. Office of Scientific Research and Development. Science, the Endless Frontier: A Report to the President on a Program for Postwar Scientific Research. By Vannevar Bush, July, 1945. Washington, D.C.: National Science Foundation, 1960, 220.

410. U.S. President's Science Advisory Committee. Joint Space Panels: The Space Program in the Post-Apollo Period. Washington, D.C.: U.S. Government Printing Office, 1967, 99.

411. U.S. President's Scientific Research Board. Science and Public Policy, Volume I: A Program for the Nation. A Report to the President by John R. Steelman. Washington, D.C.: U.S. Government Printing Office, 1947, 73.

412. Van Dyke, Vernon. Pride and Power: The Rationale of the Space Age. Urbana: University of Illinois Press, 1964, 285.

413. Warner, Malcom and Michael Stone. The Data Bank Society: Organizations, Computers, and Social Freedom. London: Allen and Unwin, 1970, 224.

414. Weinberg, Alvin M. Reflections on Big Science. Cambridge, Massachusetts: M.I.T. Press, 1967, 182.

415. Wengert, Norman. Natural Resources and the Political Struggle. Garden City, New York: Doubleday, 1955, 71.

416. Westin, Alan F., ed. Information Technology in a Democracy. Cambridge, Massachusetts: Harvard University Press, 1971, 409.

417. Weyl, F. Joachim. Research in the Service of National Purpose. Washington, D.C.: U.S. Government Printing Office, 1966, 133.

418. Wiesner, Jerome B. Where Science and Politics Meet. New York, Toronto, and London: McGraw-Hill, 1965, 302.

419. Willrich, Mason, ed. Civil Nuclear Power and International Security. New York: Praeger, 1971, 124.

420. Yarmolinsky, Adam. The Military Establishment: Its Impact on American Society. New York: Harper, 1971, 434.

LEADING QUESTIONS

1. What circumstances have drawn scientists into politics? How have the prevailing values and attitudes among scientists and their social status affected their political activities?

2. What criticisms have been directed toward high-level science policy advice in government? What has been the source of these criticisms and the reasons advanced to refute them? What alternatives have been suggested?

3. What events or reasons have been the leading factors in Federal support for scientific and technological activities? Does Congress tend "to do the right things for the wrong reasons?"

4. How would you evaluate the fears of science elitism as expressed by Lapp, Price, and others? What threat do they perceive to political responsibility and democratic institutions? What remedies are suggested?

5. What has been the personal influence of scientists in shaping U.S. science policy? Has the influence of men like Powell, Agassiz, Pinchot, and Bush led to developments in government science different from what objective analysis of national needs and interests would have indicated?

6. What have been the principal problems of the scientist-employee in government? What issues have arisen over political loyalty, national security, accountability to management, personnel and budgeting procedures, and freedom of inquiry?

7. What were the principal issues debated in the process of establishing the National Science Foundation? To what extent do these issues remain unresolved? What arguments have been advanced for and against a separate Social Science Foundation?

8. Does the public interest imply a need for the surveillance and control of investigation, experimentation, and allegation made in the name of science? If so, how should this supervision be provided? By law? By the scientific community? Through the administrative process?

9. Does the future viability of democratic government require an increased public understanding of science? Is an outlook of technoscientific determinism compatible with a commitment to self-government?

10. When moral or political judgments and scientific evidence are contradictory, which should govern public policy?

TOPIC 12 MANAGEMENT OF RESEARCH AND DEVELOPMENT

Public investment in scientific research and technological development has become mandatory in any modern nation with pretensions to power. The large amounts of money required in either absolute or relative terms, and the practical necessity for establishing priorities in the allocation of public funds among the several fields of science and technology, have made the administration of R & D a major policy area in technoscientifically advanced countries.

Specific issues regarding R & D include the following: (1) How much or what percentage of national income should be allocated for R & D and by what criteria? (2) What should be the distribution of available R & D funds among the fields of science and technology and among claimant institutions? (3) Who should determine priorities of R & D? (4) How can creativity in R & D be increased?

In the United States, at least, no clear or decisive answer to any of these questions has been forthcoming. Resolution of each of these issues has been by traditional political means. No scientific basis for choice in the shaping of policy for R & D has yet been generally accepted. Several committees of the Congress, scientific bodies, and a number of civic and educational organizations, have studied the assessment of the effects of science and technology on society and have proposed new methods for the review and evaluation of scientific and technological innovation. (See Topic 13)

The administration of R & D gives rise to sets of problems on two different levels. On the macro or national level, the allocation of funds among the fields of inquiry and among institutions are major policy questions. Closely associated is the geographical distribution of R & D money and its effects upon academic strength and economic growth in the principal regions of the country. On the micro or local-institutional level, a large number of specific issues can be identified.

Among these issues are methods for determining research priorities, promoting creativity, overcoming institutional and personal obsolescence, and avoiding undesired consequences of technological innovation (e.g., foaming detergents).

In governmental and industrial laboratories, relations between the scientific and technical staff and nonscientist administrative supervisors have frequently been difficult; the objectives of research and of mission-oriented development are often very different, and if not understood by the laboratory personnel, they may lead to conflicting viewpoints regarding the nature of the work to be done.

Perhaps the major policy problem in the administration of R & D is the bringing together of the resources of government, industry, universities, and research institutions into coherent purposeful, and yet accountable relationships. This combination of forces can form a powerhouse for the advancement of science and technology and for their wise use. The space effort provides a general model for the coordination of these forces on specific tasks. But these combinations pose serious questions for the theory and practice of responsible democratic government.

TOPIC 12 MANAGEMENT OF RESEARCH AND DEVELOPMENT

Selected Basic Readings:

Brooks, Harvey. "Models for Science Planning," Public Administration Review, XXXI (May-June, 1971), 363-374.

Hollomon, J. Herbert and Alan E. Harger. "America's Technological Dilemma," Technology Review, LXXIII (July-August, 1971), 31-40.

Kash, Don E. "Forces Affecting Science Policy," Bulletin of the Atomic Scientists, XXV (April, 1969), 10-15.

Mansfield, Edwin. "Contribution of R & D to Economic Growth in the United States," Science, CLXXV (February 4, 1972), 477-486.

Weinberg, Alvin M. "Criteria for Scientific Choice," Minerva, I (Winter, 1963), 159-171; "Scientific Choice, Basic Science and Applied Missions," Minerva, III (Summer, 1965), 515-528.

Supplementary and Substitute Readings:

Dedijer, Stevan. "Models of Science for Science Policy," Advancement of Science, XXIV (June, 1968), 498-508.

Foster, John S., Jr. "The Leading Edge of National Security," International Science and Technology, Number 82 (October, 1968), 13-21.

Gilpin, Robert. "Technological Strategies and National Purpose," Science, CLXIX (July 31, 1970), 441-448.

Haslett, Arthur W. "Little Science versus Big Science," Advancement of Science, XXVI (September, 1969), 99-105.

Nichols, Rodney W. "Mission-Oriented R & D," Science, CLXXII (April 2, 1971), 29-37.

Salomon, Jean-Jacques. "Science Policy in Perspective," Studium Generale, XXIV (Number 9, 1971), 1027-1037.

TOPICAL OUTLINE	REFERENCE KEY
I. Research and Development as Essential Functions of Technoscientific Societies	16, 51, 82, 103, 130, 139, 151, 156, 165, 175, 214
A. National goals requiring R & D support	57, 153, 157, 169, 195, 209
1. Military security	42, 49
2. Economic development	48, 66, 84, 118, 125, 143, 153, 187, 202
3. National prestige	65, 76
4. Social welfare	63
5. Ecological viability (Cf. Topic 11)	
B. Intended outcomes of R & D effort	40, 87, 157
1. Increase in national productivity	143, 146
2. Development of new products	6, 20, 25, 48, 79, 121, 186
3. Improved living conditions	125
4. Improved public health	125
5. Growth of knowledge and technique	2, 90
C. Percentage of gross national expenditure allocated to various classes of R & D	34, 62, 96, 1[illegible]7, 154, 155, 163
II. Determination of R & D Goals and Allocation of Resources to Specific Projects	36, 68, 111, 115, 122, 137, 141, 145, 159, 163, 171, 173, 174, 188, 199
A. Major decisions are made explicitly or tacitly through government	21, 50, 75, 110, 170, 197, 213

1. Government is the only source of financial means to support basic research and the more costly developmental work, e.g., atomic energy, outer space technology, advanced medical research	31, 53, 71, 91, 99, 166, 184, 185, 192, 204, 216
2. Military considerations in mixed (non-socialist) economies necessitate government funding to maintain industrial sources of military hardware, e.g., aircraft, ordinance, missiles, chemicals, communications	9, 76, 92, 100, 166, 204
3. Governmental responsibility for full employment tends to force job-making R & D (but high minimum wage rates and governmental beneficience toward unions encourage automation)	1, 6, 176, 177, 178, 181
4. As an increasing percentage of research in universities is funded through government, public policy (political) considerations, in the broad sense, tend to determine the general trend of academic efforts	29, 69, 70, 71, 73, 78, 128, 156, 191
B. Bases of R & D choices in the United States are multipartite	147, 168, 205, 206
1. Popular preconceptions and beliefs	2, 47, 71
2. Economic power	7, 79, 125, 151, 207
3. Political advantage	7, 28, 30, 47, 76, 194, 207
4. Judgment of science elites	128, 133, 135, 138
5. Interaction of foregoing factors	19, 88
C. Administration of R & D funds in the United States is	34, 155, 164, 165, 182, 193
1. Divided among a large number of Federal agencies, but is	106, 172

2. Heavily concentrated
   a. Defense — 42, 49, 64, 77, 180, 196, 207
   b. Atomic energy — 8, 132, 146
   c. Space — 24, 37, 64, 72, 76, 112, 119, 180
   d. Economic development — 7, 28, 79, 125
   e. Medicine — 174, 175, 208, 210
3. Distributed through various types of grants and contracts — 149, 174, 204

D. Generating of R & D money becomes a new form of enterprise — 5, 66, 183
1. Role of government-industry associations in formulating R & D and procurement policies and the chain-reaction effect upon substantive policy — 6, 127
2. R & D not-for-profit organizations, e.g., Battelle, Brookings Institution, RAND Corporation — 14, 200
3. Grantsmanship becomes a form of academic enterprise with side-effects upon — 78, 160
   a. Mobility of scientists
   b. Administrative control by universities over teaching, research, and faculty policies — 104
4. Geographical allocation of R & D money becomes a significant political issue and science policy an increasingly attractive forum for political influence in the Congress — 1, 2, 126

III. Policy Problems Relating to R & D Priorities — 19, 27, 35, 64, 66, 81, 86, 90, 105, 111, 114, 116, 144, 158, 192, 199, 211, 215

A. How much of the gross national expenditure should be allocated to R & D? — 29, 33, 89, 108, 178
1. What criteria for deciding "how much"? — 36, 79

2. What criteria for establishing the "best" means for making a decision? 23, 79, 132, 134, 159
   a. Economic 41, 43
      (1) Return on the allocation of resources 61, 163, 185
      (2) Comparison of this return with that from alternative uses of the resources 62, 87
   b. Social values--returns the program may offer in improved quality of life (essentially nonquantitative parameters) 22, 59, 133, 138, 179
   c. Scientific 3, 54, 80, 113, 126, 132
      (1) Expansion of frontiers of knowledge in the field 2, 46
      (2) "Timeliness" of the project 113
      (3) Relatedness to other fields of science
   d. Political
      (1) Can the taxpayers be persuaded to support the program? 144
      (2) Political implications of the proposal 38, 105
   e. Technological 13, 17, 97
      (1) Efficiency of implementation of the desired end 46
      (2) Improvement of the state of the art 2, 46, 101, 113

B. Within the range of possibilities, what guidelines, if any, exist to indicate priorities? 36, 45, 88, 98, 102, 132, 159, 164, 167

1. On what assumptions do present allocations appear to be made? 138, 162, 185
2. What criticisms of allocations are most frequently made? 32, 55, 183
   a. Subject matter of R & D 56, 113, 138
   b. Methods of allocation 194

(1) Reactive rather than initiative
(2) Project and peer group methods
(3) Have--have not--competition

c. Geographical allocation of funding — 113, 160

d. Distribution of resulting benefits — 160

C. What means of public ordering of priorities have been tried or advocated to serve the public interest more effectively (Cf. Topics 6, 11, 13)? — 71, 88, 102, 105, 108, 162, 169, 199

1. Recommendations for a high-level review body in the Federal government
   a. Department of Science
   b. Boards of Review (Executive, Legislative, and mixed)
2. Upgrading and broadening the capabilities of public officials for wise judgment on questions of public policy for science and technology — 58, 67
3. Strengthening the staff resources of the Congress with respect to policy issues relating to science and technology — 194, 209

BIBLIOGRAPHY

General References: Articles

1. Abelson, Philip H. "The Research and Development Pork Barrel," Science, CXLIX (July 2, 1965), 11.

2. Anderson, Paul. "Are the Big Machines Necessary?" New Scientist and Science Journal, LI (September 2, 1971), 510-513.

3. Appleton, Edward. "Science for Its Own Sake," Advancement of Science, X (September, 1953), 103-112.

4. Argyris, Chris. "On the Effectiveness of Research and Development Organizations," American Scientist, LVI (Winter, 1968), 344-355.

5. Artsimovich, Lev A. "The Modern Physicist and the Case for Science Politics," Bulletin of the Atomic Scientists, XXIV (November, 1968), 23; 41-48.

6. Ayres, Richard U. "Governmental Policy and Prospects for Technology-Based Industry," Professional Engineer, XLI (December, 1971), 38-41.

7. ________. "We May Be Losing Our Technological Lead," Innovation, Number 17 (January, 1971), 12-19.

8. Bacher, Robert F. "Research and the Development of Atomic Energy," Science, CIX (January 7, 1949), 2-7.

9. Barnes, Carl E. "To Promote Invention," International Science and Technology, Number 60 (December, 1966), 67-73.

10. Beckler, David. "Strategic Federal Decision-Making on R & D," Research Management, IX (September, 1966), 319-333.

11. Berkner, Lloyd V. "Government Sponsorship of Scientific Research," Science, CXXIX (March 27, 1959), 817-821.

12. Bertin, Leonard. "Science Policy in Canada," Technology Review, LXXIII (February, 1971), 35-39.

13. Best, Robert D. "The Scientific Mind vs. the Management Mind," Industrial Research, V (October, 1963), 764-784.

14. Bolman, Frederick de W. "The Effect of Government Grants on Foundations," Educational Record, XLIX (Winter, 1968), 103-108.

15. Brode, Wallace R. "Approaching Ceilings in the Supply of Scientific Manpower," Science, CXLIII (January 24, 1964), 313-324.

16. ________. "The Growth of Science and a National Science Program," American Scientist, L (March, 1962), 1-28.

17. Brooks, Harvey. "Applied Science and Technological Progress," Science, CLVI (June 30, 1967), 1706-1712.

18. ________. "Future Needs for the Support of Basic Research," in Knowledge and Power: Essays on Science and Government, ed. by Sanford A. Lakoff. New York: Free Press, 1966, 432-468.

19. ________. "Models for Science Planning," Public Administration Review, XXXI (May-June, 1971), 363-374.

20. Cahn, Robert W. "Case History of Innovations," Nature, CCXXV (February 21, 1970), 693-695.

21. Cairncross, Alvin. "Government and Innovation," New Scientist and Science Journal, LI (September 2, 1971), 502-505.

22. Caldwell, Lynton K. "Authority and Responsibility for Environmental Administration," Annals of the American Academy of Political and Social Science, CCCLXXXIX (May, 1970), 107-115.

23. Carter, Charles F. "The Distribution of Scientific Effort," Minerva, I (Winter, 1963), 172-181.

24. Carter, Luther J. "Post-Apollo: NASA Seeks a Mars Flight Plan," Science, CLXV (September 5, 1969), 987-991.

25. Charpie, Robert A. "Technological Innovation and the International Economy," Science Policy News, I (July, 1969), 1-6.

26. Clarke Robin. "How the 300 Ge V Decision Was Made," Science Journal, V (March, 1969), 4-5; 7.

27. Clayton, Robert. "A Convergent Approach to R & D Planning and Project Selection," Research Management, XIV (September, 1971), 68-74.

28. Cohn, Victor. "Not Like the Olympics," Technology Review, LXXIII (January, 1971), 10-11.

29. ________. "Science in the Begabuck Era," Technology Review, LXXIII (February, 1971), 8-9.

30. Congressional Record. "Soviet Science and Technology: Some Implications for U.S. Policy," Congressional Record, CXVI (April 14, 1970), H3056-H3062.

31. Cooper, Joseph D. "Onward the Management of Science: The Wooldridge Report," Science, CXLIX (June 11, 1965), 1433.

32. Cordtz, Dan. "Bringing the Laboratory Down to Earth," Fortune, LXXXIII (January, 1971), 106-108; 119-122.

33. Daddario, Emilio Q. "A Challenge to the Scientific Community," Proceedings of the National Academy of Sciences, LIX (February 15, 1968), 305-312.

34. Danilov, Victor J. "$27-Billion for Research," Industrial Research, XII (January, 1970), 46-49.

35. Dedijer, Stevan. "Models of Science for Science Policy," Advancement of Science, XXIV (June, 1968), 498-508.

36. Dobrov, George M. "Criteria of Choice: A Complex Problem of the Science of Science," Selections from Voprosy Filosofii, Number 3 (June 16, 1969), 18-31. (U.S.S.R. Joint Publications Research Service)

37. Dryden, Hugh L. "Space Knowledge and Its Impact on Future Research," Research Management, II (Summer, 1959), 67-80.

38. Dyson, Freeman. "Death of a Project," Science, CXLIX (July 9, 1965), 141-144.

39. Encel, Samuel. "The Support of Science without Science Policy in Australia," Minerva, IX (July, 1971), 349-360.

40. Feibleman, James K. "Importance of Technology," Nature, CCIX (January 8, 1966), 122-125.

41. Fishlock, David. "The 'Fall-Out' from the Space Race," New Scientist, XVIII (May 30, 1963), 480-481.

42. Foster, John S., Jr. "The Leading Edge of National Security," International Science and Technology, Number 82 (October, 1968), 13-21.

43. Freeman, Christopher. "The Evaluation of Science," New Scientist, XXX (June 9, 1966), 660-662.

44. ________. "Research Comparisons," Science, CLVIII (October 27, 1967), 463-468.

45. Freeman, Christopher, et al. "The Goals of R & D in the 1970s," Science Studies, I (October, 1971), 357-406.

46. Frey, Leonard, Jr. "The United States in Space--Technological Benefits and Achievements," Congressional Record, CXVII (May 17, 1971), H3984-H3986.

47. ________. "The United States in Space--U.S. versus U.S.S.R.," Congressional Record, CXVII (May 20, 1971), H4152-H4154.

48. Fryers, Gordon. "Technological Innovation and the Growth of the Economy," Science Policy News, I (July, 1969), 18-21.

49. Garwin, Richard L. "Strengthening Military Technology," Science and Technology, Number 82 (October, 1968), 22-27.

50. Gillette, Robert, Deborah Shapley, and Nicholas Wade. "1973 Budget: Administration Bets on Applied Science," Science, CLXXV (January 28, 1972), 389-392.

51. Gilpin, Robert. "Technological Strategies and National Purpose," Science, CLXIX (July 31, 1970), 441-448.

52. Gordon, Gerald, Odin Anderson, and Sue Marquis. "Organization for Scientific Productivity," American Behavioral Scientist, V (December, 1961), 35-37.

53. Gordon, Gerald, Ann Parelius, and Sue Marquis. "Public versus Private Support of Science," American Behavioral Scientist, X (May, 1967), 29-32.

54. Greenberg, Daniel S. "Money for Research: Congress and Scientists Have Different Ideas on How the System Should Operate," Science, CXLIX (July 16, 1965), 278-280.

55. ________. "The Scientific Pork Barrel," Harper's Magazine, CCXXXII (January, 1966), 90-92.

56. ________. "Social Science: Federal Agencies Agree to End Covert Support," Science, CLIX (January 5, 1968), 64-66.

57. Grossfield, Karl. "National Interest Aspects of Innovation," Advancement of Science, XXV (March, 1969), 335-343.

58. Gustafson, W. Eric. "Science vs. Administrative Evangelism," Public Administration Review, XXII (Spring, 1962), 84-88.

59. Hammond, Allen L. "Federal R & D: Domestic Problems Get New Efforts but Little Money," Science, CLXXI (February 19, 1971), 657-661.

60. Haslett, Arthur W. "Little Science versus Big Science," Advancement of Science, XXVI (September, 1969), 99-105.

61. Heiss, Klaus P. "Our R & D Economics and the Space Shuttle," Astronautics and Aeronautics, IX (October, 1971), 50-62.

62. Hill, Robert B. "The Improvement of Returns from Research and Development Investment," Advancement of Science, XXV (March, 1969), 269-278.

63. Hollomon, J. Herbert. "Modern Engineering and Society: The Marriage between Technical Ability and Social Needs," Chemical and Engineering News, XLII (June 29, 1964), 66-71.

64. Hollomon, J. Herbert and Alan E. Harger. "America's Technological Dilemma," Technology Review, LXXIII (July-August, 1971), 31-40.

65. Holme, Thomas T. "Produce and Compete or Perish," American Scientist, LVI (Summer, 1968), 138-158.

66. Johnson, Harry G. "Federal Support of Basic Research: Some Economic Issues," Minerva, III (Summer, 1965), 499-523.

67. Jones, Richard V. "Impotence and Achievement in Physics and Technology," Nature, CCVII (July 10, 1965), 120-125.

68. Kash, Don E. "Forces Affecting Science Policy," Bulletin of the Atomic Scientists, XXV (April, 1969), 10-15.

69. ________. "Research and Development at the University," Science, CLX (June 21, 1968), 1313-1318.

Kaysen, Carl. "Allocating Federal Support for Basic Research," Bulletin of the Atomic Scientists, XXII (January, 1966), 16-22.

71. ________. "Government and Scientific Research--Some Unanswered Questions," The Public Interest, XXIV (Summer, 1971), 80-85.

72. Kerr, Breene M. "Spin-Off from Space," Science Journal, I (July, 1965), 85-90.

73. Kidd, Charles V. "The Effect of Research Emphasis on Research Itself," Chapter 4 in Research and Medical Education. Evanston, Illinois: Association of American Medical Colleges, 1962, 95-122.

74. Killian, James R. "Science and Public Policy," Science, CXXIX (January 16, 1959), 129-136.

75. Klaw, Spencer. "The Nationalization of U.S. Science," Fortune, LXX (September, 1964), 158-160; 180; 182; 185-186.

76. Kohler, Foy D. and Dodd L. Harvey. "Administering and Managing the U.S. and Soviet Space Programs," Science, CLXIX (September 11, 1970), 1049-1056.

77. Kreilkamp, Karl. "Hindsight and the Real World of Science Policy," Science Studies, I (January, 1971), 43-66.

78. Leaf, Alexander. "Government, Medical Research, and Education," Science, CLIX (February 9, 1968), 604-607.

79. Lewis, Herbert J. "The Enhancement of Technology and Vice-Versa," SPPSG Newsletter, II (October, 1971), 1-4.

80. Lindsay, Dale R. and Ernest M. Allen. "Medical Research: Past Support, Future Directions," Science, CXXXIV (December 22, 1961), 2017-2024.

81. Lipsitt, Harold A. "Decision-Making in National Science Policy," European Scientific Notes, XXII (April 30, 1968), 82-86. (Office of Naval Research, London)

82. McIntyre, Thomas J. "The Importance of Research and Development," Congressional Record, CXVII (September 8, 1971), S13880-S13882.

83. Mandelbaum, Leonard. "Apollo: How the U.S. Decided to Go to the Moon," Science, CLXIII (February 14, 1969), 649-654.

84. Mansfield, Edwin. "Contribution of R & D to Economic Growth in the United States," Science, CLXXV (February 4, 1972), 477-486.

85. Marshak, Robert E. "Basic Research in the University and Industrial Laboratory," Science, CLIV (December 23, 1966), 1521-1524.

86. Massey, Harrie S.W. "Problems of Science Policy," Proceedings of the Royal Institution of Great Britain, XLI (Number 191, 1967), 379-479.

87. Melville, Harry. "Can Research Be Made Productive?" Nature, CCXII (October 1, 1966), 7-9.

88. Mosher, Charles A. "Counterbudget: A Blueprint for Changing National Priorities, 1971-1976--Chapter 14. Research and Development," Congressional Record, CXVII (May 21, 1971), E4874-E4877.

89. Nature. "Is There a Future for Science in the United States?" Nature, CCXXVI (April 25, 1970), 297-299.

90. Nelson, Richard R. "'World Leadership', the 'Technological Gap', and National Science Policy," Minerva, IX (July, 1971), 386-399.

91. Newman, James R. and Byron S. Miller. "The Socialist Island," Bulletin of the Atomic Scientists, V (January, 1949), 13-15.

92. Nichols, Rodney W. "Mission-Oriented R & D," Science, CLXXII [illegible] 2, 1971), 29-37.

93: Nieburg, Harold L. "R & D Program Implementation," in Proceedings of the Symposium on National R & D for the 1970's, held in Washington, D.C., October 18-19, 1967. Washington, D.C.: National Security Industrial Association, 1968, 203-210.

94. OECD Observer. "Progress in Science Policy," OECD Observer, Number 30 (October, 1967), 12-15.

95. ________. "Research Policy in Canada," OECD Observer, Number 44 (February, 1970), 8-12.

96. ________. "Resources Devoted to Research and Development in OECD Member Countries," OECD Observer, Number 30 (October, 1967), 32-41.

97. ________. "Technological Forecasting," OECD Observer, Number 27 (April, 1967), 33-36.

98. Orlans Harold. "Some Current Problems of Government Science Policy: What Should Be the Balance between Expenditures on Pure and Applied Sciences and Who Should Set It?" Science, CXLIX (July 2, 1965), 37-40.

99. Parsegian, V. Lawrence. "Atomic Transition--To What?" Bulletin of the Atomic Scientists, XXII (January, 1966), 23-26.

100. Pettit, Lawrence K. "Congress, Confusion, and Indirect Costs," Science, CLXIII (March 21, 1969), 1301-1305.

101. Pierce, John R. "What Are We Doing to Engineering?" Science, CXLIX (July 23, 1965), 397-399.

102. Pitzer, Kenneth S. "Rethinking Our Scientific Priorities," Chemical Technology, Number 1 (May, 1971), 273-277.

103. Pognos, Samuel S. "Research and Development--and the Congress," GAO Review, Number 1 (Spring, 1968), 40-46.

104. Price, Don K. "Federal Money and University Research," Science, CLXI (January 21, 1966), 285-290.

105. Price, Don K. "Professionals and Politicians," Chapter 7 in The Scientific Estate. Cambridge, Massachusetts: Harvard University Press, 1965, 208-269.

106. Price, William J. "The Case for Agency Research," Bulletin of the Atomic Scientists, XXV (April, 1969), 34-36.

107. Randle, C. Wilson. "Problems of R & D Management," Harvard Business Review, XXXVII (January-February, 1959), 128-136.

108. Reagan, Michael D. "R & D: Suggestions for an Allocations Framework," Public Administration Review, XXVII (June, 1967), 104-111.

109. ________. "$17 Billion in Search of a Policy," Bulletin of the Atomic Scientists, XXIV (April, 1968), 33-36.

110. Reinecke, Eugene. "Who Makes Technology Decisions on the Scientist-Oriented Washington Scene?" American Engineer, XXXVIII (May, 1968), 37-40.

111. Roberts, Edward B. "The Myths of Research Management," Science and Technology, Number 80 (August, 1968), 40-46.

112. Rolan, Robert G. "Must We Choose between Men in Space and Mankind on Earth?" AIBS Bulletin (BioScience), XX (July 15, 1970), 797-806.

113. Rosen, Louis. "Relevance of Particle Accelerators to National Goals," Science, CLXXIII (August 6, 1971), 490-497.

114. Rubenstein, Albert H. "Setting Criteria for R & D," Harvard Business Review, XXXV (January-February, 1957), 95-104.

115. Salomon, Jean-Jacques. "Science Policy in Perspective," Studium Generale, XXIV (Number 9, 1971), 1027-1037.

116. Sapolsky, Harvey M. "Science Advice for State and Local Government," Science, CLX (April 19, 1968), 280-284.

117. Sayre, Wallace S. "Scientists and American Science Policy," Science, CXXXIII (March 24, 1961), 859-864.

118. Science of Science Foundation Newsletter. "Technological Innovation and the Growth of the National Economy," Science of Science Foundation Newsletter, IV (April, 1969), 5-14.

119. Seamans, Robert C., Jr. "The Space Program and the Needs of the Nation," Astronautics and Aeronautics, VII (October, 1969), 62-75.

120. Sebrell, William H. and Charles V. Kidd. "Administration of Research in the National Institutes of Health," Scientific Monthly, LXXIV (March, 1952), 152-161.

121. Slichter, Sumner H. "The Industry of Discovery," Science, CXXVIII (December 26, 1958), 1610-1613.

122. Solandt, Omar M. "Formulating a National Science Policy," Science of Science Foundation Newsletter, III (April, 1968), 5-13.

123. Storer, Norman W. "Some Sociological Aspects of Federal Science Policy," American Behavioral Scientist, VI (December, 1962), 27-30.

124. Stover, Carl F. "Industry, Technology, and Metropolitan Problems," Public Administration Review, XXVII (June, 1967), 112-117.

125. Thurow, Lester C. "Research, Technical Progress, and Economic Growth," Technology Review, LXXIII (March, 1971), 45-52.

126. Toulmin, Stephen E. "The Complexity of Scientific Choice: A Stock-taking," Minerva, II (Spring, 1964), 343-359.

127. U.S. Atomic Energy Commission. "Report of the Industrial Advisory Group," Bulletin of the Atomic Scientists, V (February, 1949), 51-55.

128. U.S. President's Science Advisory Committee. "Strengthening the Behavioral Sciences," Science, CXXXVI (April 20, 1962), 233-241.

129. Walsh, John. "Congress: Subcommittee Surveys Effect of Federally Supported Research on Higher Education," Science, CXLIX (July 2, 1965), 42-44.

130. Waterman, Alan T. "Federal Support of Science," Science, CLIII (September 16, 1966), 1359-1361.

131. Waterman, Alan T. "Integration of Science and Society," American Behavioral Scientist, VI (December, 1962), 3-6.

132. Weinberg, Alvin M. "Criteria for Scientific Choice," Minerva, I (Winter, 1963), 159-171.

133. ________. "Science, Choice, and Human Values," Bulletin of the Atomic Scientists, XXII (April, 1966), 8-13.

134. ________. "Scientific Choice, Basic Science, and Applied Missions," Minerva, III (Summer, 1965), 515-523.

135. ________. "Scientific Choice and the Scientific Muckrakers: Review Article," Minerva, VII (Autumn-Winter, 1968-1969), 52-67.

136. Weisskopf, Victor F. "Why Pure Science?" Bulletin of the Atomic Scientists, XXI (April, 1965), 4-8.

137. Wiesner, Jerome B. "Rethinking Our Scientific Objectives," Technology Review, LXXI (January, 1969), 15-17.

138. Zuckerman, Solly. "Technological Choice: The Social Cost," New Scientist, XLVIII (December 3, 1970), 389-391.

General References: Books

139. Allison, David, ed. The R and D Game: Technical Men, Technical Managers, and Research Productivity. Cambridge, Massachusetts: M.I.T. Press, 1969, 322.

140. American Institute of Management. Research and Development in the Corporation: Its Meaning, Its Evaluation. New York: American Institute of Management, 1957, 93.

141. Barber, Richard J. The Politics of Research. Washington, D.C.: Public Affairs Press, 1966, 167.

142. Berberet, Jerome A. The Measurement of the Scientific and Technological Capabilities of Nations. Santa Barbara, California: Tempo, Independent Research Program, General Electric Company, 1968, 57.

143. Bond, Floyd A., ed. Technological Change and Economic Growth. Ann Arbor: Graduate School of Business Administration, University of Michigan, 1965, 59.

144. Brooks, Harvey. Can Science Be Planned? Cambridge, Massachusetts: Program on Technology and Society, Harvard University, 1967, 20.

145. ________. The Government of Science. Cambridge, Massachusetts: M.I.T. Press, 1968, 343.

146. Cambel, Ali B., et al. Energy Research and Development and National Progress. Report prepared for the Interdepartmental Energy Study Group under the Direction of.... Washington, D.C.: U.S. Government Printing Office, 1966, 437.

147. CIBA Foundation. Decision Making in National Science Policy. Boston: Little, Brown, 1968, 309.

148. Cockcroft, John, ed. The Organization of Research Establishments. New York: Cambridge University Press, 1966, 281. (British Experience)

149. Danhoff, Clarence H. Government Contracting and Technical Change. Washington, D.C.: Brookings Institution, 1968, 472.

150. Danielson, Lee E. Characteristics of Engineers and Scientists: Significance for their Motivation and Utilization. Ann Arbor: Bureau of Industrial Relations, University of Michigan, 1960, 136.

151. Denison, Edward F. The Sources of Economic Growth in the United States and the Alternatives before Us. New York: Committee for Economic Development, 1962, 297.

152. de Reuck, Anthony V.S., Maurice Goldsmith, and Julie Knight, eds. Decision-Making in National Science Policy. Boston: Little, Brown, 1968, 310.

153. Fawcett, Samuel L. Adapting Technology to Encourage Economic Development. Paper presented at the Tenth Meeting of the Board of Governors, Inter-American Development Bank, Guatemala, April 9, 1969, 15.

154. Fisher, William H. Probable Levels of R&D Expenditures in 1972: Forecast and Analysis. Columbus, Ohio: Battelle Memorial Institute, 1971, 9.

155. Fisher, William H. and Leonard L. Lederman. Probable Levels of R & D Expenditures in 1970 - Forecast and Analysis. Columbus, Ohio: Battelle Memorial Institute, 1969, 8.

156. Freeman, Charles and Allen Young. The Research and Development Effort in Western Europe, North America, and the Soviet Union. Paris: Organization for Economic Cooperation and Development, 1965, 152.

157. Helmer, Olaf and Ted Gordon. Social Technology. New York: Basic Books, 1966, 108.

158. Hogg, Quintin M. (Lord Hailsham). Science and Politics. Chicago: Encyclopedia Brittanica Press, 1965, 110.

159. Jul, Mogens. Selecting Priorities for Major Research: A European View. New York: American Management Association, Research and Development Division, 1969, 20.

160. Keenan, Boyd R., ed. Science and the University. New York: Columbia University Press, 1966, 219.

161. Kidd, Charles V. American Universities and Federal Research. Cambridge, Massachusetts: Harvard University Press, 1959, 272.

162. Lambright, William H. Public Administration and Science and Technology. Syracuse, New York: Syracuse University, 1969, 28.

163. Lederman, Leonard L. and Margaret L. Windus. Federal Funding and National Priorities: An Analysis of Programs, Expenditures, and Development. New York: Praeger, 1971, 213. (Prepared with the Assistance of Battelle Memorial Institute, Columbus Laboratories)

164. March, Michael S. Federal Budget Priorities for Research and Development. Chicago: University of Chicago Center for Policy Study, 1970, 45.

165. Mikulak, Roland. A Second Look at U. S. and Soviet Research and Development. Cambridge, Massachusetts: Center for International Studies, Massachusetts Institute of Technology, 1971, 35. (Report B71-1)

166. National Academy of Sciences. National Academy of Engineering. Committee on Public Engineering Policy. Federal Support of Applied Research. Report of the Ad Hoc Tosk Force on Roles of the Federal Government in Applied Research. Washington, D.C.: National Academy of Engineering, 1970, 16.

167. ________. National Academy of Engineering. Committee on Public Engineering Policy. Priorities in Applied Research, An Initial Appraisal. Washington, D.C.: National Academy of Engineering, 1970, 33.

168. Notional Acodemy of Sciences - National Research Council. Criteria for Federal Support of Science. A Panel Discussion Arronged by the Division of Physical Sciences, March 11, 1969. Washington, D.C.: Notional Research Council, 1969, 39.

169. ________. Committee on Science and Public Policy. Basic Research and National Goals. A Report to the Committee on Science and Astronautics of the U.S. House of Representatives. Washington, D.C.: U.S. Government Printing Office, 1965, 336.

170. ________. Committee on Science and Public Policy. Federal Support of Basic Research in Institutions of Higher Learning. Washington, D.C.: National Academy of Sciences - National Research Council, 1964, 98. (Publication Number 1185)

171. National Science Foundation. An Analysis of Federal R & D Funding by Budget Function, 1960-1972. Washington, D.C.: U.S. Government Printing Office, 1971, 93. (NSF 71-25)

172. ________. Federol Funds for Research, Development, and Other Scientific Activities, Fiscal Years, 1968, 1969, and 1970. Surveys of Science Resources Series, Volume XVIII. Washington, D.C.: U.S. Government Printing Office, 1969, 280. (NSF 69-31)

173. ________. Federal Funds for Research, Development, and Other Scientific Activities, Fiscal Yeors 1969, 1970, and 1971. Surveys of Science Resources Series, Volume XIX. Washington, D.C.: U.S. Government Printing Office, 1971, 264. (NSF 70-38)

174. ________. Federal R & D Expenditures Related to Budget Functions, 1960-1972. Washington, D.C.: U.S. Government Printing Office, 1971, 4. (NSF 71-19).

175. National Science Foundation. Federal R & D Funding Shows Upward Trend. Washington, D.C.: U.S. Government Printing Office, 1971, 4. (NSF 71-24)

176. ________. Industrial R & D Spending, 1969. Washington, D.C.: U.S. Government Printing Office, 1971, 4. (NSF 70-47)

177. ________. Industrial R & D Spending, 1970. Washington, D.C.: U.S. Government Printing Office, 1971, 4. (NSF 71-39)

178. ________. National Patterns of R & D Resources: Funds and Manpower in the United States, 1953-1971. Washington, D.C.: U.S. Government Printing Office, 1971, 38. (NSF 70-46)

179. ________. Research and Development Activities of Local Governments, Fiscal Years 1966 and 1967. Washington, D.C.: U.S. Government Printing Office, 1969, 60. (NSF 69-14)

180. ________. Research and Development in the Aircraft and Missiles Industry, 1957-1968. Washington, D.C.: U.S. Government Printing Office, 1969, 17. (NSF 69-15)

181. ________. Research and Development in Industry, 1968. Washington, D.C.: U.S. Government Printing Office, 1970, 110. (NSF 70-29)

182. National Security Industrial Association. National R & D for the 1970's. Proceedings of the Symposium, held in Washington, D.C., October 18-19, 1967. Washington, D.C.: National Security Industrial Association, 1968, 235.

183. Nieburg, Harold L. In the Name of Science. Chicago: Quandrangle, 1966, 444.

184. Organization for Economic Cooperation and Development. Fundamental Research and the Policies of Governments. Paris: OECD, 1966, 72.

185. ________. Government and Allocation of Resources to Science. Paris: OECD, 1966, 66.

186. ________. Government and Technical Innovation. Paris: OECD, 1966, 59.

187. Organization for Economic Cooperation and Development. Science, Economic Growth, and Government Policy. Paris: OECD, 1963, 98.

188. Orlans, Harold, ed. Science Policy and the University. Washington, D.C.: Brookings Institution, 1968, 3[illegible]2.

189. Orth, Charles D., III, Joseph C. Bailey, and Francis W. Wolek. Administering Research and Development: The Behavior of Scientists and Engineers in Organizations. Homewood, Illinois: Irwin, 1964, 585.

190. Pelz, Donald C. and Frank M. Andrews. Scientists in Organizations: Productive Climates for Research and Development. New York: Wiley, 1966, 318.

191. Riccard, Paul J., ed. Science and Policy Issues. Itasca, Illinois: F.E. Peacock, 1969, 156.

192. Reagan, Michael D. Science and the Federal Patron. New York: Oxford University Press, 1969, 346.

193. Rivkin, S.R. Technology Unbound: Transferring Scientific and Engineering Resources from Defense to Civilian Purposes. New York and London: Pergamon, 1968, 102.

194. Roback, Herbert. Role of Congress in R & D Allocations. Paper presented at the 1967 Meeting of the American Association for the Advancement of Science, held in New York, December 28, 1967. New York: American Association for the Advancement of Science, 1967, 28.

195. Roman, Daniel D. Research and Development Management: The Economics and Administration of Technology. New York: Appleton-Century-Croft, 1968, 450.

196. Rose, Steven, ed. CBW: Chemical and Biological Warfare. London: Harrap, 1968, 209.

197. Schoettle, Eugene C. Civilian-Military Interest in New Technologies. Washington, D.C.: George Washington University, 1968, 78.

198. Schon, Donald A. Technology and Change: The New Heraclitus. New York: Delacorte Press, 1967, 248.

199. Shils, Edward, ed. Criteria for Scientific Development: Public Policy and National Goals. Cambridge, Massachusetts: M.I.T. Press, 1967, 200.

200. Smith, Bruce L. The RAND Corporation: Case Study of a Nonprofit Advisory Corporation. Cambridge, Massachusetts: Harvard University Press, 1966, 430.

201. United Nations Educational, Scientific, and Cultural Organization. Principles and Problems of National Science Policies. Paris: UNESCO, 1967, 99.

202. ________. The Role of Science and Technology in Economic Development. Paris: UNESCO, 1970, 216. (Science Policy Studies and Documents, Number 18)

203. U.S. Bureau of the Budget. The Administration of Government-Supported Research at Universities. Washington D.C.: U.S. Government Printing Office, 1966, 141.

204. U.S. Comptroller General. Allowances for Independent Research and Development Costs in Negotiated Contracts, Issues and Alternatives. Washington, D.C.: General Accounting Office, 1970, 117.

205. U.S. Congress. House. Committee on Armed Services. Subcommittee on Armed Forces Investigating. Independent Research and Development. Hearings before the Subcommittee, under the authority of House Resolution 105, to the 91st Congress, 2nd Session, February 15, 16, and March 2, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 273.

206. ________. Committee on Armed Services. Subcommittee on Armed Services Investigating. Review of Independent Research and Development Program Management. Report of the Subcommittee, under the authority of House Resolution 105, to the 91st Congress, 2nd Session, September 18, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 20.

207. U.S. Congress. Joint Economic Committee. Subcommittee on Economy in Government. Military Budget and National Economic Priorities. Hearings before the Subcommittee to the 91st Congress, 1st Session, June 3-24, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 992. (Three Parts)

208. U.S. Congress. Senate. Committee on Government Operations. Subcommittee on Executive Reorganization and Government Research. Health Activities: Federal Expenditures and Public Purpose. Analysis, Pursuant to Senate Resolution 329, Submitted by the Subcommittee to the 91st Congress, 2nd Session, June, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 40.

209. ________. Committee on Government Operations. Subcommittee on Government Research. An Inventory of Congressional Concern with Research and Development (88th and 89th Congresses): A Bibliography. Prepared for the Subcommittee by the Science Policy Research Division, Legislative Reference Service, Library of Congress, 89th Congress, 1st Session, December 15, 1966. Washington D.C.: U.S. Government Printing Office, 1966, 120.

210. ________. Committee on Labor and Public Welfare. Expanding, Improving, and Better Coordinating (the) Family Planning Services and Population Research Activities of (the) Federal Government. Senate Report 91-1004 of the Committee to Accompany S 2108 to the 91st Congress, 2nd Session, July 7, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 21.

211. ________. Committee on Public Works. Problems and Issues of a National Materials Policy. Papers delivered at an Engineering Foundation Research Conference on National Materials Policy, July, 1970, and prepared for the Committee by Franklin P. Huddle, Science Policy Research Division, Legislative Reference Service, Library of Congress, 91st Congress, 2nd Session, December 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 272.

212. U.S. Federal Council for Science and Technology. Proceedings--First Symposium: Current Problems in the Management of Scientific Personnel, October 17-18, 1963. Washington, D.C.: U.S. Government Printing Office, 1964, 131.

213. U.S. Office of Science and Technology. Revised Memorandum and Statement of Government Patent Policy. Washington, D.C.: U.S. Government Printing Office, 1971, 21.

214. U.S. President's Task Force on Science Policy. Science and Technology: Tools for Progress. Washington, D.C.: U.S. Government Printing Office, 1970, 48.

215. Weinberg, Alvin M. Reflections on Big Science. Cambridge, Massachusetts: M.I.T. Press, 1967, 256.

216. Wooldridge, Dean E., et al. Biomedical Science and Its Administration: A Study of The National Institutes of Health. Washington, D.C.: U.S. Government Printing Office, 1965, 213.

LEADING QUESTIONS

1. How might it be determined that the existing level of support of basic research in an area of science is not sufficient to maintain the rate of growth of that field: would you ask experts in that field alone, or would you also call in outsiders?

2. An economist, Denison, has calculated that the rate of return from investments in R & D programs has been only about that of investments in nonresidential real estate. Would you accept the analogy between R & D expenditures and real estate investments?

3. What has been the effect of Federal support of science on the existing character of the universities doing scientific work? Has the rise of national research laboratories diminished the relative importance of the universities in scientific research?

4. Is there really a national policy for the support of basic scientific research? What would be the implications of such a policy, how could it be implemented in practice, and what are some of the arguments against a single Federal "science budget"?

5. Some writers have charged that there are alternative programs, e.g., a war against poverty or improvement of existing health facilities, which would not require any basic research for their implementation and would promise a better rate of return in social and economic goods than the space race or high energy physics. Have their arguments taken all relevant factors into account?

6. Toulmin, Weinberg, and others have attempted to formulate criteria for the evaluation of proposals for scientific research. What factors have they taken to be important? Do their illustrative evaluations seem satisfying?

7. From an overview of the present funding practices of Federal support for basic scientific research, would you judge that our estimates of the probable returns from such expenditures have been based upon the cultural or the mission-oriented values of science? What consequences would follow from the method of estimating benefits?

8. What would be some probable outcomes if Federal support of science were drastically curtailed?

9. What factors should be considered in allocating resources among the various sciences? Is it possible to predict, on the basis of present trends, any changes in the relative amounts of support of the physical, biological, and social sciences?

10. What are some of the proposals that have been made to obtain more disinterested, more broadly beneficial, and more responsible decisions regarding the emphasis and funding of research and development projects?

TOPIC 13 TECHNOLOGICAL FORECASTING AND ASSESSMENT

Experience with the consequences of technological innovation has indicated the desirability of foreseeing the possible effects of technological change. Technological forecasting has become of special concern to persons responsible for social, economic, or industrial planning. Investment houses, banks, and many business firms have an obvious concern with the economic implications of technological change, and they are therefore anxious to foresee the course of technological development. Governments must also be alert to the character and implications of technological change, as nearly every facet of public policy could be affected by the complex interactions among modern technologies.

The objective of forecasting is not only to estimate the direction in which technology is likely to develop, but also to discover the directions in which it can and should (or should not) move. This examination of the implications and potentialities of technology is called technology assessment. Concern for the effects of technology has been stimulated by the environmental and psycho-physical consequences of a large number of technological innovations. Examples range from the radiation hazards of microwaves propagated by household electronic appliances, to the ecological consequences of pesticides, to the physiological and atmospheric effects of supersonic flight.

One of the more highly developed systems of assessment is in the area of pharmacology and medicine, as provided in the United States by the Food and Drug Administration and the National Institutes of Health. The rapidly developing field of chemical technology has created a need for greater information and controls over new products, and an international registry of chemical compounds has been proposed. A more positive approach to technology assessment is the analysis of the kinds of technologies needed to attain specific social goals. Thus assessment can be used to discover and develop beneficial new technologies as well as to protect against harmful effects.

It is difficult and, in general, unwise to separate technological forecasting and assessment from its total ecological and social context. Assessment of the costs, risks, and benefits of a technology requires some standards of welfare or value. Moreover, the conditions required for the development or control of a particular technology may be of a social, economic, political, or ethical nature not directly evident in an isolated examination of the technology itself. Technological forecasting and assessment tend, therefore, to induce more comprehensive systems analyses of all major trends in society, leading toward a "science" of possible futures or "futurology".

TOPIC 13 TECHNOLOGICAL FORECASTING AND ASSESSMENT

Selected Basic Readings:

Jantsch, Erich. "Toward a Methodology for Systematic Forecasting," Technological Forecasting, I (Number 4, 1970), 409-419.

Jones, Martin V. "The Methodology of Technological Assessment," Futurist, VI (February, 1972), 19-26.

Kiefer, David M. "Assessing Technology Assessment," Futurist, V (December, 1971), 234-239.

Roberts, Edward B. "Exploratory and Normative Technological Forecasting: A Critical Appraisal," Technological Forecasting, I (Number 2, 1969), 113-127.

U.S. Congress. House. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Technology Assessment. Statement by Emilio Q. Daddario before a Subcommittee of the 90th Congress, 1st Session, July 3, 1967. Washington, D.C.: U.S. Government Printing Office, 1967, 19.

Supplementary and Substitute Readings:

Abt, Clark C. "An Approach to Methods of Combined Sociotechnological Forecasting," Technological Forecasting and Social Change, II (Number 1, 1970), 17-22.

Dror, Yehezkel. "A Policy Sciences View of Futures Studies: Alternative Futures and Present Action," Technological Forecasting and Social Change, II (Number 1, 1970), 3-16.

Forrester, Jay W. "Counterintuitive Behavior of Social Systems," Technological Forecasting and Social Change, III (Number 1, 1971), 1-22.

McHale, John. "World Facts and Trends: Man in the Biosphere, Environmental System(s), Human Systems," Futures, III (September, 1971), 216-301.

Platt, John R. "How Men Can Shape Their Future," Futures, III (March, 1971), 32-47.

Salomon, Jean-Jacques. "Science Policy and Its Myths," Futures, III (March, 1971), 11-23.

TOPICAL OUTLINE	REFERENCE KEY
I. Need for Technological Forecasting and Assessment	5, 21, 27, 43, 47, 54, 63, 70, 94, 123, 127, 134, 138, 152, 159, 182, 183, 204, 319, 336, 338
A. Danger of unforeseen side-effects of powerful new technologies. The large increase in world population with reduced margins for error means that there are very few areas in which risky experiments can be conducted, and consequences are less likely to be confined locally	71, 93, 99, 133, 144, 166, 167, 177, 185, 248, 266
B. Basis for economic choice and investment, as well as for rational development planning. Rapid advances in science and technology necessitate a high selectivity on the part of the decision maker not only at a national level, but at the level of the individual industrial enterprise. Forecasting techniques are valuable tools in identifying alternate possibilities for choice	34, 36, 73, 77, 80, 82, 100, 114, 116, 150, 160, 161, 169, 174, 218, 236, 242, 298, 323
C. Systematic means are needed to estimate impacts which technological developments are likely to have on society in the future, and for guiding the application of new knowledge toward goals set by society. Also necessary to determine priorities of fields in which new knowledge is urgently needed	28, 48, 49, 66, 72, 75, 78, 103, 121, 122, 128, 139, 141, 142, 162, 186, 192, 227, 263, 272, 278, 275, 324, 350, 359, 362

II. Early Efforts at Forecasting	39, 102, 198, 208, 317
A. Observed correlations between stellar constellations and the annual floods in the valley of the Tigris and Euphrates gave the Mesopotamian priests--the first known forecasters--an enormous political and economic power	202
B. Implicit forecasts in the Middle Ages and the Renaissance--da Vinci, Bacon's New Atlantis, etc.	198
C. Forecasts made to promote specific developments, e.g., aircraft, space travel, and communications satellites	229, 244
D. Forecasts used as warning against dangers in specific technologies such as electronic eavesdropping and genetic engineering	202
E. Other wide-ranging forecasts up to World War II	19, 163, 209, 271, 285, 321, 343, 369
F. Science fiction as a semi-intellectual exercise with emphasis on entertainment value--the novels by Jules Verne, H. G. Wells, Aldous Huxley, and George Orwell	107, 414
III. Systematic Technological Forecasting	17, 25, 31, 32, 46, 79, 83, 88, 158, 159, 179, 190, 199, 202, 212, 224, 225, 275, 299, 318, 328
A. Inclusion of social, technological, and military environments in forecasting--National Research Council report of 1937, "Technological Trends and National Policy"	349, 352

4. Bertrand de Jouvenel's "Futuribles" Program — 239
5. Robert Jungk's Project on "Mankind 2000" — 302
6. Institute for the Future — 252, 278, 295, 320.
7. International organizations such as OECD, EURATOM, ICAO — 250
8. Private industry — 67, 114, 129, 351, 408, 409, 417

E. Some current methods of technological forecasting — 37, 64, 97, 105, 109, 118, 140, 147, 157, 202, 212, 216, 364

1. <u>Exploratory forecasting</u> starts from current basis of knowledge and attempts to predict the technological state-of-the-art in a given time frame — 147, 199, 202
   a. Trend extrapolation to either a straight line fit or an S-shaped expectation — 52, 126, 314, 386
   b. "Genius Forecasting" by individual experts — 277, 307, 322, 383
   c. "Brainstorming"--group meeting deliberately set up to stimulate "way out" thinking
   d. The "Delphi" technique--forecasts made by panels of experts not in direct communication with each other — 18, 20, 30, 50, 151, 175, 176
   e. "Cross Impact" studies--the effects of several alternate developments on the subjects of the forecasts — 30, 115, 280
   f. "Gaming" and "Scenario Writing"--participants asked to simulate a specific role in a "scenario." In "Scenario Writing," the emphasis is on the critical branch points, where small influences may have large effect on outcome — 65, 191, 193

g. Modeling and simulation — 54, 85, 115, 203, 268, 297, 320, 327, 336, 358

2. Normative forecasting first assesses future goals, and works backward to the present-- "Inventing the Future" — 3, 59, 104, 147, 272

a. Morphological Analysis--a technique for identifying, indexing, counting, and parametrizing the collection of all possible devices to achieve a specified functional capability. Can also be used for identifying and counting all possible means to a given end at any level of abstraction or aggregation — 132, 420

b. "Operations Research" and "Systems Analysis" as forms of self-fulfilling technological forecasts (cf. Topic 15) — 54, 84, 112, 113, 360, 374

3. Drawbacks of the exploratory-normative classification. Need to look beyond this for creative synthesis and additional perspectives — 2, 33, 56, 147, 148, 164, 165

IV. Technology Assessment — 11, 40, 41, 60, 76, 86, 93, 101, 106, 136, 139, 154, 180, 181, 231, 265, 345, 347, 390, 392, 396

A. The nature of technology assessment — 98, 110, 335, 344

1. A form of policy research which provides a balanced appraisal to the policymaker — 195, 232, 334, 387, 391, 393

2. Identifies policy issues, assesses the impact of alternative courses of action, and presents findings — 130, 197, 381, 391

3. Analytical methods which vary from case to case, and appraise the nature, significance, status, and merit of a technological program — 29, 45, 125, 233, 363, 366, 395, 397, 398

B. The scope of technology assessment — 13, 14, 90, 92, 93, 162, 166, 196, 210, 231, 329, 330

1. Measurement of physical parameters such as climate and weather modification, famine, epidemics, radiation effects — 197, 217, 258, 270
2. Establishment of cause-and-effect relationships, with special emphasis on second- and third-order effects — 9, 149, 205
3. Risk-versus-reward ratios for different nations, e.g., use of DDT in India may be desirable, but not necessarily so in the U.S.A.
4. Emphasis on short-term impacts that can be measured by natural science parameters, but long-range effects such as possible changes in values, attitudes, or institutions also considered — 89, 98, 108, 121, 145, 149, 172, 178, 185, 195, 200, 207, 219, 320, 407, 410

C. Some areas in critical need of technology assessment — 99, 110, 112, 155, 177, 187, 204, 221, 258, 259, 287, 308, 331, 340

1. Energy production from fossil fuel, nuclear plants, and other sources — 62, 69, 111, 184, 289, 354, 376
2. Phosphates and other substances in water — 217
3. Short- and long-term effects of pesticides — 171, 217
4. The role of the automobile in transportation — 10, 28
5. Supersonic passenger aircraft — 26
6. Further growth of the cities — 42, 291, 384

7. Fertility control drugs	130, 269
8. Genetic Engineering	367, 379, 416
D. Steps involved in technology assessment	85, 153, 189, 332, 340
1. Identification of all areas influenced by a program—in physical, social, economic, and legal sectors	91, 173, 333, 341
2. Establishment of cause-and-effect relationships, including indirect effects	54, 84, 112, 113, 205
3. Determination of alternative methods to implement the program	51, 260
4. Identification of alternative programs to achieve the same goals and possible impacts associated with them	51, 260
5. Evaluation of all the bad, as well as good, impacts of the program	171, 205
6. Presentation of findings from the analysis, and recommendations	45, 125

BIBLIOGRAPHY

General References: Articles

1. Abrams, Mark. "Mass Views of the Future: A Report from the Netherlands," Futures, III (June, 1971), 103-115.

2. Abt, Clark C. "An Approach to Methods of Combined Sociotechnological Forecasting," Technological Forecasting and Social Change, II (Number 1, 1970), 17-22.

3. Alderson, R. C. and W. C. Sproull. "Requirement Analysis, Need Forecasting, and Technology Planning Using the Honeywell PATTERN Technique," Technological Forecasting and Social Change, III (Number 2, 1972), 255-265.

4. Alexander, W. O. "Metals and Non-Metallic Materials," Futures, I (December, 1969), 500-509.

5. Allison, David. "Measuring the Good and the Bad of New Technology," Innovation, (Number 9, 1970), 44-55.

6. American Association for the Advancement of Science. Committee on Science in the Promotion of Human Welfare. "The Integrity of Science," American Scientist, LIII (June, 1965), 174-198.

7. Anderson, John. "Medical Education and Practice in 2000," Futures, II (March, 1970), 54-58.

8. Architectural Design. "2000 +," Special Issue of Architectural Design, XXXVII (February, 1967), entire issue.

9. Austin, Arthur L. "World Population Growth and Related Technical Problems," Technological Forecasting and Social Change, III (Number 1, 1971), 23-49.

10. Barbiroli, Giancarlo. "Forecasting and Planning the Energy Source for Cars," Futures, III (June, 1971), 135-141.

11. Barker, Ann and Jo Ann Fowler. "Technology Assessment," AIBS Bulletin (BioScience), XIX (October, 1969), 923-924; 934-935.

12. Bar-Zakay, Samuel N. "Technology Transfer Model," Technological Forecasting and Social Change, II (Numbers 3 and 4, 1971), 321-337.

13. Basuik, Victor. "Perils of the New Technology," Foreign Policy, II (Spring, 1971), 51-68.

14. ________. "Technology, Western Europe's Alternative Futures, and American Policy," Orbis, XV (Summer, 1971), 485-506.

15. Beer, Stafford. "The Liberty Machine," Futures, III (December, 1971), 338-348.

16. ________. "Managing Modern Complexity," Futures, II (June, 1970), 114-122.

17. Bell, Daniel. "Twelve Modes of Prediction--a Preliminary Sorting of Approaches in the Social Sciences," Daedalus, XCIII (Summer, 1964), 845-880.

18. Bender, A. Douglas, Alvin E. Strack, George W. Ebright, and George von Haunalter. "Delphic Study Examines Developments in Medicine," Futures, I (June, 1969), 289-303.

19. Benson, Allan L. "Interview with Thomas Edison: The Wonderful New World Ahead of Us," Cosmopolitan Magazine, L (February, 1911), 294-306.

20. Bernstein, G. B. and Marvin J. Cetron. "SEER: A Delphic Approach Applied to Information Processing," Technological Forecasting, I (Number 1, 1969), 33-54.

21. Bertram, Christoph. "Models of Western Europe in the 1970's--The Alternate Choices," Futures, I (December, 1968), 142-152.

22. Bjerrum, Christen A. "Forecast of Computer Developments and Applications 1968-2000," Futures, I (June, 1969), 331-338.

23. Borgstrom, Georg. "The World Food Crisis," Futures, I (June, 1969), 339-355.

24. Bouladon, G. "Aviation's Role in Future Transportation," Technological Forecasting and Social Change, I (Number 1, 1969), 5-16.

25. Bratt, Elmer C. "Methodology in Long-Range Forecasting," Commercial and Financial Chronicle, CXCI (February 4, 1960), 10-11.

26. Brookner, E. "Applying Technology to Civilian Problems," Astronautics and Aeronautics, IX (March, 1971), 36-51.

27. Brown, Harrison S. "Herman Cohn in Retrospect," Futurist, V (August, 1971), 157-159.

28. Brown, R. "Telecommunications: The Next 20 Years," New Scientist and Science Journal, LI (July 1, 1971), 13-20.

29. Busignies, Henri. "Electrical Communication and Civilization," Research Management, XIV (July, 1971), 14-26.

30. Campbell, George S. "Methodology, Relevance of Signal Monitoring to Delphi/Cross-Impact Studies: Illustrative Example for Energy Resources," Futures, III (December, 1971), 404.

31. Carter, Anne P. "Technological Forecasting and Input-Output Analysis," Technological Forecasting, I (Number 4, 1970), 331-345.

32. Cetron, Marvin J. "Forecasting Technology," International Science and Technology, Number 69 (September, 1967), 83-92.

33. ________. "A Method for Integrating Goals and Technological Forecasts into Planning," Technological Forecasting and Social Change, II (Number 1, 1970), 23-51.

34. Cetron, Marvin J. and Bodo Bartocha. "A Forecasting Model to Aid Research and Development Planning," Futures, I (December, 1969), 479-487.

35. Cetron, Marvin J. and D. N. Dick. "Producing the First Navy Technological Forecast," Technological Forecasting, I (Number 2, 1969), 185-195.

36. Cetron, Marvin J. and Edmund B. Mahinske. "The Value of Technological Forecasting for the Research and Development Manager," Futures, I (September, 1968), 21-33.

37. Chambers, John C., S. K. Mullick and D.D. Smith. "How to Choose the Right Forecasting Techniques," Harvard Business Review, XLIX (July-August, 1971), 45-74.

38. Chavchanidze, Vladimir. "Induction of Psychointellectual Activity in Long-Term Forecasting and Planning of Research: Psychoheuristic Programming," Technological Forecasting, I (Number 2, 1969), 129-139.

39. Clarke, I. F. "The Pattern of Prediction 1763-1973," Futures, continuing series of articles in the journal: (June, 1969), 325-330; (September, 1969), 464-468; (December, 1969), 553-557.

40. Congressional Record. "The Technology Assessment Act of 1970," Congressional Record, CXVI (April 16, 1970), H3225-H3226.

41. ________. "Technology Assessment Act of 1971," Congressional Record, CXVII (July 19, 1971), S11346-S11350.

42. Contini, Edgardo. "The American City--A Forecast," Futurist, VI (February, 1972), 5-12.

43. David, Edward E., Jr. "Some Questions on the Role and Effectiveness of Technology Assessment," Research Management, XIV (March, 1971), 21-23.

44. Diebold, John. "What's Ahead in Information Technology," Harvard Business Review, XLIII (September-October, 1965), 76-82.

45. Djerassi, Carl. "Fertility Control Through Abortion: An Assessment of the Period 1950-1980," Bulletin of the Atomic Scientists, XXVIII (January, 1972), 9-14; 41-45.

46. Doty, John P. and Robert J. Lord. "Does TF Really Work?" Harvard Business Review, XLIX (November-December, 1970), 16-28; 168.

47. Dror, Yehezkel. "A Policy Sciences View of Futures Studies: Alternative Futures and Present Action," Technological Forecasting and Social Change, II (Number 1, 1970), 3-16.

48. ________. "The Role of Futures in Government," Futures, I (September, 1968), 40-46.

49. Eldredge, H. Wentworth. "Education for Futurism in the United States: An On-Going Survey and Critical Analysis," Technological Forecasting and Social Change, II (Number 2, 1970), 133-148.

50. Enzer, Selwyn. "Delphi and Cross-Impact Techniques--An Effective Combination for Systematic Futures Analysis," Futures, III (March, 1971), 48-61.

51. Eugster, Carl. "Corporate Planning in an Unstable Environment," Futures, III (December, 1971), 357-371.

52. Fisher, J. C. and R. H. Pry. "A Simple Substitution Model of Technological Change," Technological Forecasting and Social Change, III (Number 1, 1971), 75-88.

53. Flores, Edmundo. "The Big Threat Is Not Hunger," Ceres, II (May-June, 1969), 19-21.

54. Forrester, Jay W. "Counterintuitive Behavior of Social Systems," Technological Forecasting and Social Change, III (Number 1, 1971), 1-22.

55. ________. "Engineering Education and Practice in 2000," Futures, I (September, 1969), 391-401.

56. Foster, Richard N. and Robert H. Rea. "An Integrated Technological Forecasting and Planning System," Futures, II (Numbers 3 and 4, 1970), 231-244.

57. Fredriksson, Ingrid. "The Future Role of Women," Futures, I (December, 1969), 532-540.

58. Fusfeld, Alan R. and Richard N. Foster. "The Delphi Technique: Survey and Comment," Business Horizons, XIV (June, 1971), 63-74.

59. Gabor, Dennis. "Normative Technological Forecasting," Technological Forecasting, I (Number 1, 1969), 1-4.

60. George Washington Law Review. "Technology Assessment Symposium," George Washington Law Review, XXXVI (July, 1968), 1033-1149.

61. Gilfillian, S. Colum. "The Prediction of Technological Change," Review of Economics and Statistics, XXXIV (November, 1952), 368-385.

62. Glaser, Peter E. "Solar Energy--An Alternative Source for Power Generation," Futures, I (June, 1969), 304-313.

63. Go[illegible]farb, Avrom J. "Technological Forecasting: What and Whither?" Technological Forecasting and Social Change, III (Number 1, 1971), 51-64.

64. Gordon, Theodore J. and H. Hayward. "Initial Experiments with the Cross-Impact Matrix Method of Forecasting," Futures, I (December, 1968), 100-116.

65. Gordon, Theodore J., S. Enzer, and Richard Rochberg. "An Experiment in Simulation Gaming of Social Policy Studies," Technological Forecasting, I (Number 3, 1970), 241-261.

66. Handler, Philip. "Remarks on the Conduct of Science in the Environment of the 1970's," Technological Forecasting and Social Change, II (Number 2, 1970), 115-123.

67. Haverda, J. [illegible] "Forecasting Human Behavior in an International Corporation," Futures, III (March, 1971), 24-31.

68. Helmer-Hirschberg, Olaf and Nicholas Rescher. "On the Epistemology of the Inexact Sciences," Management Science, VI (October, 1959), 25-52.

69. Hoffman, George A. "Future Electric Automobiles," Technological Forecasting, I (Number 2, 1969), 173-183.

70. Huber, Bettina J. and Wendell Bell. "Sociology and the Emergent Study of the Future," American Sociologist, VI (November, 1971), 287-295.

71. Huddle, Franklin P. "The Social Management of Technological Consequences," Futurist, VI (February, 1972), 16-18.

72. Hunt, H. "Forecasting the Need for Research and Development," Futures, I (September, 1969), 382-390.

73. Huntley, James R. "Gaps in the Future: The American Challenge and the European Challenge," Futures, II (March, 1970), 5-14.

74. IEEE Transactions on Engineering Management. "Selected Papers by the Working Group on Research Management, 22nd Military Operations Research Symposium (MORS)," IEEE Transactions, EM-16 (November, 1969), entire issue.

75. Ikle, Fred C. "Social Forecasting and the Problem of Changing Values, With Speical Reference to Soviet and East European Writing," Futures, III (June, 1971), 142-150.

76. Innovation. "Making Technology Assessable," Innovation, XXV (October, 1971), 57-59.

77. Isenson, Raymond S. "Technological Forecasting; A Planning Tool," in Multinational Corporate Planning, ed. by George A. Steiner and Warren M. Cannon. New York: Macmillan, 1966, 330.

78. Jantsch, Erich. "Integrative Planning of Society and Technology: The Emerging Role of the University," Futures, I (March, 1969), 185-190.

79. ________. "New Organizational Forms for Forecasting," Technological Forecasting, I, (Number 2, 1969), 151-161.

80. ________. "The Organization of Technological Forecasting in the Soviet Union: Notes from a Brief Visit," Technological Forecasting, I (Number 1, 1969), 83-86.

81. ________. "Planning and Designing for the Future," Futures, I (September, 1969), 440-444.

82. ________. "Technological Forecasting at National Level in Japan: Notes from a Brief Visit," Technological Forecasting, I (Number 3, 1970), 325-327.

83. ________. "Toward a Methodology for Systematic Forecasting," Technological Forecasting, I (Number 4, 1970), 409-419.

84. ________. "World Dynamics," Futures, III (June, 1971), 162-169.

85. Jones, Martin V. "The Methodology of Technological Assessment," Futurist, VI (February, 1972), 19-26.

86. Jungk, Robert. "Human Futures," Futures, I (September, 196[illegible] 34-39.

87. ________. "Look-Out Institutions for Shaping the Environment," Futures, I (March, 1969), 227-231.

88. Kaplan, Abraham, A. L. Skogstad, and Meyer A. Girshick. "The Prediction of Scientific and Technological Events," Public Opinion Quarterly, XIV (Spring, 1950), 93-110.

89. Kaplan, Max. "Leisure as an Issue for the Future," Futures, I (December, 1968), 91-99.

90. Kash, D. E. and J. L. White. "Technology Assessment: Harnessing Genius," Chemical and Engineering News, XLIX (November 29, 1971), 36-41.

91. Katz, M. "The Function of Tort Liability in Technology Assessment," Cincinnati Law Review, XXXVIII (Fall, 1969), 587-662.

92. Kiefer, David M. "Assessing Technology Assessment," Futurist, V (December, 1971), 234-239.

93. ________. "Technology Assessment," Chemical and Engineering News, XLVIII (October 5, 1970), 42-56.

94. Kohl, Walter H. "Assessment, Transfer and Forecasting of Technology," Spectrum, XLVII (January, 1971), 70-75.

95. Kölbel, H. and J. Schulze. "Chemical Products of the Future," Universitas, XIII (Number 3, 1971), 217-221.

96. Kreiger, James H. "Technology Assessment and Industry's Role," Chemical and Engineering News, XLVIII (January 19, 1970), 32.

97. Lanford, H. W. "Problems in the Teaching of Technological Forecasting," Technological Forecasting, I (Number 4, 1970), 421-426.

98. LaPorte, Todd R. "The Context of Technology Assessment: A Changing Perspective for Public Organization," Public Administration Review, XXXI (January-February, 1971), 63-73.

99. Lear, John. "Predicting the Consequences of Technology," Saturday Review, LIII (March 28, 1970), 44-46.

100. Leontief, Wassily W. "The Structure of the U.S. Economy," Scientific American, CCXII (April, 1965), 25-35.

101. Lepkowski, W. "Federal Technology Policy Begins to Take Shape," Product Engineering, (February 16, 1970), 24-26.

102. Lescarboura, Austin C. "The Future as Suggested by the Developments of the Last 75 Years," Scientific American, CXXIII (October 2, 1920), 320-321.

103. Linstone, Harold A. "A University for the Post-Industrial Society," Technological Forecasting, I (Number 3, 1970), 263-281.

104. ________. "When Is a Need a Need? The Problem of Normative Forecasting in a Changing Environment," Technological Forecasting, I (Number 1, 1969), 55-72.

105. Lisichkin, Vladimir A. "The Process of Making Forecasts," Technological Forecasting, I (Number 1, 1969), 97-104.

106. Livingston, Dennis. "International Technology Assessment and the United Nations System," American Journal of International Law, LXIV (September, 1970), 163-172.

107. ________. "Science Fiction as a Source of Forecast Material," Futures, I (March, 1969), 232-238.

108. Lompe, Klaus. "Problems of Futures Research in the Social Sciences," Futures, I (September, 1968), 47-53.

109. Lovewell, P. J. and R. D. Bruce. "How We Predict Technological Change," New Scientist, XIII (February 15, 1962), 370-373.

110. McElheny, Victor K. "Technology: Trying to be Rational," Technology Review, LXXIII (June, 1971), 12-13.

111. McHale, John. "World Energy Resources in the Future," Futures, I (September, 1968), 4-13.

112. ________. "World Facts and Trends: Comparative Indicators," Futures, III (December, 1971), 385-395.

113. ________. "World Facts and Trends: Man in the Biosphere, Environ System(s), Human Systems," Futures, III (September, 1971), 216-301.

114. Mansfield, Edwin. "The Speed of Response of Firms to New Techniques," Quarterly Journal of Economics, LXXVII (May, 1963), 290-311.

115. Martino, Joseph P. "Computers and Technological Forecasting," Futurist, V (October, 1971), 205-206.

116. ________. "Examples of Technological Trend Forecasting for Research and Development Planning," Technological Forecasting and Social Change, II (Numbers 3 and 4, 1971), 247-260.

117. ________. "Forecasting the Progress of Technology," Air University Review, XX (March-April, 1969), 11-20. Aerospace Studies Institute, Maxwell Air Force Base, Alabama.

118. ________. "How to Select a Parameter," Futurist, V (June, 1971), 115-116.

119. ________. "Technological Forecasting and the Autonomy of Technology," Technological Forecasting, I (Number 1, 1969), 73-82.

120. ________. "Technological Forecasting in the U.S. Air Force," Futurist, V (December, 1971), 251-252.

121. Mayo, Louis H. "Relationship of Technology Assessment to 'Balanced Social Growth': Commentary on Paper by Dr. Seitz," in Harmonizing Technological Developments and Social Policy in America, ed. by James C. Charlesworth and Alfred J. Eggers, Jr. Philadelphia: American Academy of Political and Social Science, 1970, 172-189.

122. Meadows, Dennis L. "Estimate Accuracy and Project Selection Models in Industrial Research," Industrial Management Review, IX (Spring, 1968), 105-119.

123. Menke-Glückert, Peter. "Mankind in the World of Tomorrow," Technological Forecasting and Social Change, II (Numbers 3 and 4, 1971), 231-235.

124. Mero, John L. "Oceanic Mineral Resources," Futures, I (December, 1968), 125-141.

125. Miller, G. A. "Assessment of Psychotechnology," American Psychologist, XXV (November, 1970), 991-1001.

126. Mohn, M. Carroll, Jr. "Application of Trend Concepts in Forecasting Typesetting Technology," Technological Forecasting and Social Change, III (Number 2, 1972), 225-253.

127. New York Times Magazine. "The Future," New York Times Magazine (April 19, 1964), Section 6; Part 2, 86-118.

128. North, Harper Q. and Donald L. Pyke. "Technological Forecasting to Aid R&D Planning," Research Management, XII (July, 1969), 289-296.

129. ________. "Technology, the Chicken--Corporate Goals, the Egg," in First Annual Technology and Management Conference, ed. by James R. Bright. Englewood Cliffs, New Jersey: Prentice-Hall, 1968.

130. Ohio State Law Journal. "Population Control in the Year 2000: The Constitutionality of Placing Anti-Fertility Agents in the Water Supply," Ohio State Law Journal, XXXII (Winter, 1971), 108-118.

131. OECD Observer. "Innovation in German Universities," OECD Observer, Number 45 (April, 1970), 8-11.

132. O'Neal, Charles R. "Morphological Analysis: An Integrative Approach," Business Horizons, XIII (December, 1970), 47-58.

133. Page, J. K. "Possible Developments in the Urban Environment," Futures, II (September, 1970), 215-221.

134. Peccei, Aurelio. "Problems of World Future," Technological Forecasting, I (Number 3, 1970), 229-233.

135. Peretz, David. "Thirty-Five Years of Change for the Financial System," Futures, III (December, 1971), 349-356.

136. Physics Today. "Government Interest in Technology Assessment Grows," Physics Today, XXIII (April, 1970), 61-62.

137. Pierce, Chester M. "The Pre-Schooler and the Future," Futurist, VI (February, 1972), 13-15.

138. Platt, John R. "How Men Can Shape Their Future," Futures, III (March, 1971), 32-47.

139. Price, R. "Technology Assessment," Congressional Record, CXVII (January 29, 1971), E278-E279..

140. Quinn, James B. "Technological Forecasting," Harvard Business Review, XLV (March-April, 1967), 89-106.

141. ________. "Top Management Guides for Research Planning," in Research, Development, and Technological Innovation, ed. by James R. Bright. Homewood, Illinois: Richard D. Irwin, 1964, 677-700.

142. Quinn, James B. and Robert M. Cavanaugh. "Fundamental Research Can Be Planned," Harvard Business Review, XLII (January-February, 1964), 111-124.

143. Ramo, Simon. "Towards Scientific Anticipation of Change," Astronautics and Aeronautics, VII (October, 1969), 44-49.

144. Ravetz, J. R. "Towards Critical Science," New Scientist and Science Journal, LI (September 23, 1971), 681-683.

145. Richards, Brian. "Urban Transportation and City Form," Futures, I (March, 1969), 239-251.

146. Ridenour, Louis N. "Physical Science and the Futures," in Facing the Future's Risks--Studies toward Predicting the Unforeseen, ed. by Lyman Bryson. New York: Harper, 1953, 60-89.

147. Roberts, Edward B. "Exploratory and Normative Technological Forecasting: A Critical Appraisal," Technological Forecasting, I (Number 2, 1969), 113-127.

148. ________. "Technological Forecasting: A Critical Appraisal," in Technological Forecasting--A Practical Approach, ed. by Marvin J. Cetron. New York: Technology Forecasting Institute, [illegible]9, 297-340.

149. Rosen, S. "Science and Technology Approach Year 2000," New Scientist and Science Journal, L (April 8, 1971), 76-79.

150. Rosenberg, Nathan. "Economic Development and the Transfer of Technology: Some Historical Perspectives," Technology and Culture, XI (October, 1970), 550-575.

151. Salancik, J. R., William Wenger, and Ellen Helfer. "The Construction of Delphi Event Statements," Technological Forecasting and Social Change, III (Number 1, 1971), 65-73.

152. Salomon, Jean-Jacques. "Science Policy and Its Myths," Futures, III (March, 1971), 11-23.

153. Sandow, Stuart. "The Pedagogy of Planning: Defining Sufficient Futures," Futures, III (December, 1971), 324-337.

154. Science News. "Technology Assessment: Feeling Their Way," Science News, XCVII (March 7, 1970), 240-241.

155. Science Policy News. "Let the People Speak on the Impact of Technology," Science Policy News, (January, 1970), 83-87.

156. Seamans, Robert C., Jr. "Space," Science Journal, III (October, 1967), 82-88.

157. Sheppard, William J. "Relevance Analysis in Research Planning," Technological Forecasting, I (Number 4, 1970), 371-379.

158. Shostak, A. B. and A. S. Pennington. "Methodology: Futurism Pro and Con," Futures, III (June, 1971), 173-176.

159. Siegel, Irving H. "Technological Change and Long-Run Forecasting," Journal of Business of the University of Chicago, XXVI (July, 1953), 141-156.

160. Simmonds, W. H. C. "The Analysis of Industrial Behavior and Its Use in Forecasting," Technological Forecasting and Social Change, III (Number 2, 1972), 205-224.

161. Sorrows, H. E. "Technology Forecasting--A Profitmaker Eliminates Blind Chance for Industry," Commerce Today, I (July 26, 1971), 8-13.

162. Starr, Chauncey. "Technology Assessment--I: Weighing the Benefits and Risks of New Technologies," Research Management, XIII (November, 1970), 409-425.

163. Steinmetz, Charles P. "You Will Think This a Dream," Ladies' Home Journal, XXXII (September 15, 1915).

164. Sulc, Oto. "Interactions between Technological and Social Changes: A Forecasting Model," Futures, I (September, 1969), 402-407.

165. ________. "A Methodological Approach to the Integration of Technological and Social Forecasts," Technological Forecasting, I (Number 1, 1969), 105-108.

166. Tanenbaum, Morris. "Technology Assessment--II: Its Effects on Science and Engineering," Research Management, XIII (November, 1970), 427-434.

167. Taylor, Gordon R. "Trends in Pollution," Futures, II (June, 1970), 105-113.

168. Thring, M. W. "Machines for a Creative Society," Futures, II (March, 1970), 45-53.

169. Thurston, P. H. "Make TF Serve Corporate Planning," Harvard Business Review, XLIX (September-October, 1971), 98-102.

170. Timm, Bernhard. "Chemistry and Nutrition in 2000 A.D.," Universitas, XIII (Number 2, 1971), 110-134.

171. Tishler, M. "A New Goal for Science," Saturday Review, LIV (June 5, 1971), 56-58.

172. Tizard, J. "On Planning Research Training in the Social Sciences," Futures, III (March, 1971), 62-67.

173. Tribe, L. H. "Legal Frameworks for the Assessment and Control of Technology," Minerva, IX (April, 1971), 243-255.

174. Turner, Louis. "The Multi-National Corporations: Considerations for a Scenario," Futures, III (June, 1971), 151-161.

175. Turoff, Murray. "Delphi Conferencing: Computer-Based Conferencing with Anonymity," Technological Forecasting and Social Change, III (Number 2, 1972), 159-204.

176. ________. "The Design of a Policy Delphi," Technological Forecasting and Social Change, II (Number 2, 1970), 149-171.

177. Van Tassel, Alfred J. "A Seminar Exercise in Forecasting Ecological Changes: Pollution from Rising Industrial Output," Technological Forecasting and Social Change, II (Numbers 3 and 4, 1971), 237-245.

178. Vickers, Geoffrey. "Changing Ethics of Distribution," Futures, III (June, 1971), 116-134.

179. Vogel, Peter H. "A Basis for Technological Forecasting," Technological Forecasting, I (Number 3, 1970), 313-323.

180. Vohra, Hans R. "Preventive Technology: Rival Proposals in Congress," Bulletin of the Atomic Scientists, XXVII (March, 1971), 25-26.

181. Walsh, John. "Technology Assessment: NAS Panel Asks New Federal Mechanisms," Science, CLXV (September 5, 1969), 992-994.

182. Walsh, Warren B. "Soviet Research Priorities: Exercises in Forecasting," American Behavioral Scientist, VIII (December, 1964), 3-6.

183. Waskow, Arthur I. "The Historian's Role in Futures Research," Futures, I (December, 1968), 117-124.

184. Weinberg, Alvin M. "Prudence and Technology: A Technologist's Response to Predictions of Catastrophe," BioScience, XXI (April 1, 1971), 333-335; 338.

185. Winthrop, Henry. "Social Costs and Studies of the Future," Futures, I (December, 1969), 488-499.

186. Wormuth, Francis D. "Government and Science," Center Magazine, III (March-April, 1970), 41-46.

187. Wren-Lewis, John. "Faith in the Technological Future," Futures, II (September, 1970), 258-262.

188. Zeman, Milos. "Futurology--Illusion or Reality?" Future, III (March, 1971), 6-10.

189. Zettel, R. M. "Technology Assessment: The Concept and the Practice," Chemical Technology, (September, 1971), 520-527.

General References: Books

190. Abt Associates, Inc. A Methodological Approach to Measuring Change Produced by Basic Research. Cambridge, Massachusetts: Abt Associates, 1968.

191. ________. Survey of the State of the Art: Social, Political and Economic Models and Simulations. Cambridge, Massachusetts: Abt Associates, November 26, 1965. (A report prepared for the National Commission on Technology, Automation, and Economic Progress.)

192. Abt, Clark C. Public Participation in Future Forecasting and Planning. Cambridge, Massachusetts: Abt Associates.

193. ________. Serious Games. New York: Viking Press, 1970, 176.

194. Aerospace Industries Association. Aerospace Technical Forecast 1962-1972. Washington, D.C.: Aerospace Industries Association, 1962.

195. American Academy of Arts and Sciences. Commission on the Year 2000. The Future of the United States Government toward the Year 2000. Edited by Harvey S. Perloff. New York: Braziller, 1971, xxv, 388.

196. ________. Commission on the Year 2000. Toward the Year 2000: Work in Progress. Edited by Daniel Bell. Boston: Houghton-Mifflin, 1968, 400.

197. Anderson, Stanford, ed. Planning for Diversity and Choice: Possible Futures, and Their Relations to the Man-Controlled Environment. Cambridge, Massachusetts: M.I.T. Press, 1968, 340.

198. Armytage, W. H. G. Yesterday's Tomorrows: A Historical Survey of Future Societies. Toronto, Canada: University of Toronto Press, 1968, 288.

199. Arnfield, R. V., ed. Technological Forecasting. Edinburgh: Edinburgh University Press, 1969, 413.

200. Aron, Raymond. World Technology and Human Destiny. Ann Arbor, Michigan: University of Michigan Press, 1963, 249.

201. Asimov, Isaac. Is Anyone There? New York: Ace, 1970, 319.

202. Ayres, Robert U. Technological Forecasting and Long-Range Planning. New York: McGraw-Hill, 1969, 237.

203. Bagdikian, Ben H., The Information Machines: Their Impact on Men and the Media. New York: Harper and Row, 1971, 359.

204. Baier, Kurt and Nicholas Rescher, eds. Values and the Future. New York: Free Press, 1969, 527.

205. Bauer, Raymond A., R. S. Rosenbloom, L. Sharp, et al. Second-Order Consequesces: A Methodological Essay on the Impact of Technology. Cambridge, Massachusetts: M.I.T. Press, 1969, 240.

206. Becker, Harold S. and Raul De Brigard. A Framework for Community Development Action Planning. Two Volumes. Middletown, Connecticut: Institute for the Future, 1971, 122, 282.

207. Beckwith, Burnham P. The Next 500 Years: Scientific Predictions of Major Social Trends. Jericho, New York: Exposition Press, 1967, 341.

208. Bellamy, Edward. Looking Backward. New York: Harper, 1959, 318.

209. Birkenhead, Frederick E. S. The World in 2030 A.D. London: Hodder and Stoughton, 1930, 215.

210. Black, Guy. Technology Assessment--What Should It Be? Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1971, 53.

211. Boulding, Kenneth E. The Meaning of the 20th Century. New York: Harper Colophon Books, 1964, 199.

212. Bright, James R., ed. Technological Forecasting for Industry and Government: Methods and Applications. Englewood Cliffs, New Jersey: Prentice-Hall, 1968, 484.

213. Bronwell, Arthur B., ed. Science and Technology in the World of the Future. New York: Wiley-Interscience, 1970, 394.

214. Brown, Harrison. The Challenge of Man's Future. New York: Viking Press, 1954, 290.

215. Brown, Harrison, James Bonner, and John Weir. The Next Hundred Years: Man's Natural and Technological Resources. New York: Viking Press, 1957, 193.

216. Brown, J. H. and E. S. Cheaney. Report on a Study of Future Research Activitiy and Pertinent Forecasting Techniques for Battelle's Trends in Research Study. Columbus, Ohio: Battelle Memorial Institute, 1965, 51.

217. Brown, Lester R. Seeds of Change: The Green Revolution and Development in the 1970's. New York: Praeger, 1970, 205.

218. Buchan, Alistair, ed. Europe's Futures, Europe's Choices. London: Chatto and Windus, 1969, 167.

219. Burhoe, R. W., ed. Science and Human Values in the 21st Century. Philadelphia: Westminster Press, 1971, 203.

220. Burn, Duncan L., John R. Seale, and Antony R. N. Ratcliff. Lessons from Central Forecasting, Eaton Paper 6. London: Institute of Economic Affairs, 1965, 62.

221. Calder, Nigel. The Environment Game. London: Secker and Warburg, 1967, 240.

222. Calder, Nigel, ed. Unless Peace Comes: A Scientific Forecast of New Weapons. New York: Viking Press, 1968, 243.

223. ________. The World in 1984. The New Complete Scientist Series, Two Volumes. Harmonsworth, Middlesex and Baltimore: Penguin Books, 1965, 205.

224. California Institute of Technology. The Next Ninety Years. Pasadena: California Institute of Technology, 1967, 186.

225. Cetron, Marvin J. Technological Forecasting: A Practical Approach. New York: Technology Forecasting Institute, 1969, 345.

226. Cetron, Marvin J., R. J. Happel, W. C. Hodgson, W. A. McKenney, and T. I. Monahan. A Proposal for a Navy Technological Forecast. Two Volumes. Washington, D.C.: U.S. Naval Materiel Command, 1966.

227. Charlesworth, James C. and Alfred J. Eggers, Jr., eds. Harmonizing Technological Developments and Social Policy in America. Philadelphia: American Academy of Political and Social Science, 1970, 247.

228. Chase, Stewart. The Most Probable World. New York: Harper and Row, 1968, 239.

229. Clarke, Arthur C. Profiles of the Future--An Inquiry into the Limits of the Possible. London: Victor Gollancz, 1962, 223; New York: Harper and Row, 1962, 234.

230. Clarkson, Stephen, ed. Visions 2020: Fifty Canadians in Search of a Future. Edmonton, Canada: Hurtig Publishers, 1970, 291.

231. Coates, Vary T. Examples of Technology Assessments for the Federal Government. Staff Discussion Paper 208. Washington, D.C.: George Washington University Program of Policy Studies in Science and Technology, 1970, 44.

232. ________. The Federal Government and the Current Development of Technology Assessment. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1971, 14.

233. ________. Technology Assessment of Space Stations. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1971, 61.

234. Cole, Dandridge M. Beyond Tomorrow, the Next Fifty Years in Space. Amherst, Wisconsin: Amherst Press, 1965, 168.

235. Dalkey, Norman C. Predicting the Future. Santa Monica, California: RAND Corporation, 1968, (P-3948).

236. Daniels, Loma M., compiler. Business Forecasting for the 1970s: A Selected, Annotated Bibliography. Cambridge, Massachusetts: Harvard University, Baker Library, Graduate School of Business, 1970, 48.

237. Darracott, H.T., et al. Report on Technological Forecasting. Washington, D.C.: Defense Documentation Center, 1967, 165. (AD 664 165)

238. Darwin, Charles G. The Next Million Years. Garden City, New York: Doubleday, 1952, 154.

239. DeJouvenel, Bertrand. The Art of Conjecture. Trans. by Nikita Lary. New York: Basic Books, 1967, 307.

240. Dewhurst, J. Frederic et al. America's Needs and Resources. New York: Twentieth Century Fund, 1947, 1955, 812.

241. Dickson, James F. and J. H. Brown, eds. Future Goals of Engineering in Biology and Medicine. New York: Academic Press, 1969, 359.

242. Diebold, John. Business Decisions and Technological Change. New York: Praeger, 1970, 268.

243. ______. Man and the Computer: Technology as an Agent of Social Change. New York: Praeger, 1969, 157.

244. Douhet, Giulio. The Command of the Air. Trans. by Dino Ferrari. New York: Coward-McCann, 1942.

245. Drucker, Peter F. The Age of Discontinuity. New York: Harper and Row, 1969, 394.

246. ______. America's Next 20 Years. New York: Harper and Row, 1957, 114.

247. ______. Landmarks of Tomorrow. New York: Harper and Row, 1957, 270.

248. Dubos, Rene. So Human an Animal. New York: Scribner's Sons, 1968, 267.

249. Dunstan, Mary Jane and Patricia Garlan. Worlds in the Making. Englewood Cliffs, New Jersey: Prentice-Hall, 1970, 370.

250. Economic Commission for Europe. Methods and Principles for Projecting Future Energy Requirements. New York: United Nations, 1964, 88.

251. Elliot, William Y., ed. Education and Training in the Developing Countries. New York: Praeger, 1966, 399.

252. Enzer, Selwyn. Some Developments in Plastics and Competing Materials. Middletown, Connecticut: Institute for the Future, 1971, 66.

253. Esfandiary, F. M. Optimism One: The Emerging Radicalism. New York: Norton, 1970, 249.

254. Ettinger, Robert C. W. The Prospect of Immortality. New York: Macfadden-Bartell, 1964, 160.

255. Eurich, Alvin C. Campus 1980: The Shape of the Future in American Higher Education. New York: Delacorte Press, 1968, 327.

256. Eurich, Nell. Science in Utopia: A Mighty Design. Cambridge, Massachusetts: Harvard University Press, 1967, 332.

257. Evans, Wayne O. and Nathan S. Kline, eds. Psychotropic Drugs in the Year 2000: Use by Normal Humans. Springfield, Illinois: Charles C. Thomas, 1971, 168.

258. Ewald, William R., Jr., ed. Environment and Change: The Next Fifty Years. Bloomington: Indiana University Press, 1968, 397.

259. ________. Environment for Man: The Next Fifty Years. Bloomington: Indiana University Press, 1967, 308.

260. ________. Environment and Policy: The Next Fifty Years. Bloomington: Indiana University Press, 1968, 459.

261. Fabun, Don. The Dynamics of Change. Englewood Cliffs, New Jersey: Prentice-Hall, 1967, 190.

262. Fairbrother, Nan. New Lives, New Landscapes: Planning for the 21st Century. New York: Knopf, 1970, 397.

263. Feinberg, Gerald. The Prometheus Project: Mankind's Search for Long-Range Goals. Garden City, New York: Doubleday, 1968, 215.

264. Flechtheim, Ossip K. History and Futurology. Meisenheim am Glan, Germany: Verlag Anton Hain, 1966, 126.

265. Folk, H. The Role of Technology Assessment in Public Policy. Urbana: Program on Social Implications of Science and Technology, University of Illinois, 1969, 10.

266. Forbes, R. J. The Conquest of Nature: Technology and Its Consequences. New York: Praeger, 1968, 98.

267. Foreign Policy Association, ed. Toward the Year 2018. New York: Cowles Education Corporation, 1968, 177.

268. Forrester, Jay W. World Dynamics. Cambridge, Massachusetts: Wright-Allen Press, 1971, 142.

269. Francoeur, Robert T. Utopian Motherhood: New Trends in Human Reproduction. Garden City, New York: Doubleday, 1970, 278.

270. Friedmann, Wolfgang. The Future of the Oceans. New York: Braziller, 1971, 132.

271. Furnas, Clifford C. The Next Hundred Years--The Unfinished Business of Science. New York: Reynal and Hitchcock, 1936, 434.

272. Gabor, Dennis. Inventing the Future. London: Secker and Warburg, 1963; New York: Knopf, 1964, 237.

273. Galtung, Johan. Images of the World in the Year 2000. Vienna: European Coordination Center for Research and Documentation in Social Sciences, 1970, 64.

274. Garcia, John David. The Moral Society: A Rational Alternative to Death. New York: Julian Press, 1971, 355.

275. Garrett, T. Illustrations of Technological Forecasting Techniques in Britain. NATO Defense Research Group Seminar, Technological Forecasting and Its Application to Defense Research, United Kingdom.

276. Gilfillian, S. Colum. The Sociology of Invention. Cambridge, Massachusetts: M.I.T. Press, 1935, 1970, 185.

277. Gordon, Theodore J. The Future. New York: St. Martin's Press, 1965, 184.

278. Gordon, Theodore J. and R. H. Ament. Forecasts of Some Technological and Scientific Developments and Their Societal Consequences. Middletown, Connecticut: Institute for the Future, 1969, 98. (Report R-6)

279. Gordon, Theodore J. and Olaf Helmer-Hirschberg. Report on a Long-Range Forecasting Study. Santa Monica, California: RAND Corporation, 1964, 110. (Report P-2982)

280. Gordon, Theodore J., Richard Rochberg, and Selwyn Enzer. Research on Cross-Impact Techniques with Applications to Selected Problems in Economics, Political Science and Technology Assessment. Middletown, Connecticut: Institute for the Future, 1970, 164.

281. Greenberger, Martin, ed. Computers and the World of the Future. Cambridge, Massachusetts: M.I.T. Press, 1962, 1968, 340.

282. Gregory, J. G., ed. Chemistry and Industry in the 1990s. Proceedings of a Society of Chemical Industry Symposium, July, 1969. London: Society of Chemical Industry, 1971, 195.

283. Gunn, James, ed. Man and His Future. Lawrence: University of Kansas Press, 1968, 305.

284. Halacy, Daniel S., Jr. Century 21: Your Life in the Year 2001 and Beyond. Philadelphia: Macrae Smith, 1968, 182.

285. Haldane, John B. S. Daedalus, or Science and the Future. London: Kegan Paul, 1924; New York: Dutton, 1926, 93.

286. Handler, Philip H. Can Man Shape His Future? The 1970 W. O. Atwater Memorial Lecture. Washington, D.C.: U.S. Department of Agriculture, Agriculture Research Service, 1970, 36.

287. Handler, Philip H., ed. Biology and the Future of Man. New York: Oxford University Press, 1970, 936.

288. Heinlein, Robert A. The Worlds of Robert A. Heinlein. New York: Ace Books, 1966.

289. Heiss, Klaus P., Klaus Knorr, and Oskar Morgenstern. Long Term Projections of Power: Review and Outline. Princeton, New Jersey: Mathematica, 1970, 175.

290. Hellman, Hal. Biology in the World of the Future. New York: M. Evans, 1971, 188.

291. ________. The City in the World of the Future. New York: M. Evans, 1970, 187.

292. ________. Communications in the World of the Future. New York: M. Evans, 1969, 201.

293. ________. Transportation in the World of the Future. New York: M. Evans, 1968, 188.

294. Helmer-Hirschberg, Olaf. The Future of Science. Santa Monica, California: RAND Corporation, 1967. (P-3607)

295. ________. Social Technology. New York: Basic Books, 1966, 108.

296. Isenson, Raymond, et al. Project Hindsight. First Interim Report. Springfield, Virginia: Clearinghouse for Federal Scientific and Technical Literature, 1966.

297. Ivakhnenko, A. G. and V. G. Lapa. Cybernetics and Forecasting Techniques. New York: American Elsevier, 1967, 168.

298. Jantsch, Erich. Perspectives in Planning. Paris: Organization for Economic Cooperation and Development, 1969, 527.

299. ________. Technological Forecasting in Perspective. Paris: Organization for Economic Cooperation and Development, 1967, 401.

300. Jaspers, Karl. The Future of Mankind. Trans. by E. B. Ashton. Chicago: University of Chicago Press, 1961, 342.

301. Jones, Ernest M. Advocacy in Technology Assessment. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1970, 76.

302. Jungk, Robert. Tommorrow Is Already Here. New York: Simon and Schuster, 1954, 241.

303. Jungk, Robert and Johan Galtung, eds. . Mankind 2000: International Future Research Conference. London: Allen and Unwin, 1969, 367.

304. Kahn, Herman. The Emerging Japanese Superstate: Challenge and Response. Englewood Cliffs, New Jersey: Prentice-Hall, 1970, 274.

305. ________. On Alternative World Futures: Issues and Themes. Harmon-on-Hudson, New York: Hudson Institute, 1965.

306. Kahn, Herman, et al. On Escalation: Metaphors and Scenarios. New York: Praeger, 1965, 308.

307. Kahn, Herman and Anthony J. Wiener. The Year 2000: A Framework for Speculation on the Next 33 Years. New York: Macmillan, 1967, 431.

308. Kasper, R. G. Some Comments on Technology Assessment and the Environment. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1970, 14.

309. Kasper, R. G., ed. Technology--The Proceedings of a Seminar Series. January-April, 1969, Program of Policy Studies in Science and Technology. Washington, D.C.: George Washington University, 1969, 164.

310. Keyes, Kenneth S., Jr. and J. Fresco. Looking Forward. Cranbury, New Jersey: Barnes, 1969, 204.

311. Kostelanetx, Richard. Beyond Left and Right: Radical Thought of Our Times. New York: Morrow, 1968, 437.

312. Landsberg, Hans H. Natural Resources for U.S. Growth: A Look Ahead to the Year 2000. Baltimore, Maryland: Johns Hopkins Press, 1964, 260.

313. Landsberg, Hans H., Leonard L. Fischman, and Joseph L. Fisher. Resources in America's Future. Baltimore: Johns Hopkins Press, 1963, 1017.

314. Lenz, Ralph C., Jr. Practical Application of Trend Forecasting. NATO Defense Research Group Seminar, Technological Forecasting and Its Application to Defense Research, United Kingdom.

315. ______. Technological Forecasting. Report ASD/TDR/62-414, Aeronautical Systems Division, Air Force Systems Command. Wright-Patterson Air Force Base, Ohio: Clearinghouse for Federal Scientific and Technical Literature, 1962, 106. (AD-408 085)

316. Lewin, Leonard C. Report From Iron Mountain on the Possibility and Desirability of Peace. New York: Dial Press, 1967, 109.

317. Lewisohn, Richard. Science, Prophecy and Prediction: Man's Efforts to Foretell the Future--From Babylon to Wall Street. New York: Harper and Brothers, 1961, 318.

318. Lien, Arthur P., Paul Anton, and Joseph W. Duncan. Technological Forecasting: Tools, Techniques, Applications. New York: AMA Management Bulletin, No. 115, 1968, 27.

319. Little, Dennis L., and Theodore J. Gordon. Some Trends Likely to Affect American Society in the Next Several Decades. Middletown, Connecticut: Institute for the Future, 1971, 48.

320. Little, Dennis and Richard Veller. STAPOL: A Simulation of the Impact of Policy, Values, and Technology and Society upon the Quality of Life. Middletown, Connecticut: Institute for the Future, 1970, 10.

321. Low, Alfred M. The Future. New York: International, 1925.

322. McHale, John. The Future of the Future. New York: Braziller, 1969, 322.

323. Mansfield, Edwin. The Economics of Technological Change. New York: Norton, 1968, 257.

324. March, Michael S. Federal Budget Priorities for Research and Development. Chicago: University of Chicago Center for Policy Study, 1970, 45.

325. Marien, Michael. Alternative Futures for Learning: An Annotated Bibliography of Trends, Forecasts, and Proposals. New York: Educational Policy Research Center, Syracuse University Research Corporation, 1971, 223.

326. Martin, James T. Future Developments in Telecommunications. Englewood Cliffs, New Jersey: Prentice-Hall, 1971, 414.

327. Martin, James T. and Adrian R. D. Norman. The Computerized Society: An Appraisal of the Impact of Computers on Society over the Next 15 Years. Englewood Cliffs, New Jersey: Prentice-Hall, 1970, 560.

328. Martino, Joseph P. and Thomas E. Oberbeck, eds. Approaches to Long-Range Forecasting. Washington, D.C.: U.S. Government Printing Office, 1971, 149.

329. Marx, B. S. Early Experiences with the Hazards of Medical Use of X-Rays: 1896-1906. A Technology Assessment Case Study, Staff Discussion Paper 205, Program of Policy Studies in Science and Technology. Washington, D.C.: George Washington University, 1969, 71.

330. Mayo, Louis H. The Contextual Approach to Technology Assessment: Implications for "One-Factor Fix" Solutions to Complex Social Problems. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1971, 87.

331. Mayo, Louis H. The Relationship of Technology Assessment to Environmental Management. Staff Discussion Paper 206, Program of Policy Studies in Science and Technology. Washington, D.C.: George Washington University, 1969, 34.

332. ________. Scientific Method, Adversarial System, and Technology Assessment. Washington, D.C.: Program of Policy Studies in Science and Technology, 1970, 109.

333. ________. Social Impact Analysis: 1970. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1971, 49.

334. ________. Some Implications of the Technology Assessment Function for the Effective Public Decision-Making Process. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1971, 31.

335. ________. Some Legal Jurisdictional, and Operational Implications of a Congressional Technology Assessment Component. Staff Discussion Paper 207, Program on Policy Studies in Science and Technology, Washington, D.C.: George Washington University, 1969, 56.

336. Meadows, Donella H., Dennis L. Meadows, Jørgen Randers, and William W. Behrens, III. The Limits to Growth. A Report for the Club of Rome's Project on the Predicament of Mankind. New York: Potomac Associates--Universe Books, 1972, 205.

337. Michael, Donald N. The Next Generation. New York: Vintage, 1965, 218.

338. ________. The Unprepared Society: Planning for a Precarious Future. New York: Basic Books, 1968, 132.

339. Michael, Donald N., ed. The Future Society. Chicago: Aldine, 1970, 160.

340. MITRE Corporation. Technology Assessment Methodology. 7-volume report to the White House. McClean, Virginia: MITRE Corporation, 1971:

Basic Propositions, 236.

Automotive Emission Controls, 181.

Computers-Communications Networks, 236.

Industrial Enzymes, 199.
Sea Farming, 180.
Water Pollution: Domestic Wastes, 301.
A Summary, 30.

341. Mottur, E. R. Technology Assessment and Citizen Action. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1970, 26.

342. ________. Technology Assessment and Environmental Engineering. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1970, 19.

343. Muller, Hermann J. Out of the Night—A Biologist's View of the Future. London: Victor Gollancz, 1936, 160.

344. Myrick, R., et al. Some Research Approaches to Studying the Development and Functioning of Technology Assessment-Control Processes. Washington, D.C.: George Washington University, 1969, 30. (PB 182 872)

345. National Academy of Engineering. Committee on Public Engineering Policy. A Study of Technology Assessment. Washington, D.C.: National Academy of Engineering, 1969, 208.

346. National Academy of Sciences. Applied Science and Technological Progress. A report to the Committee on Science and Astronautics, U.S. House of Representatives. Washington, D. C.: U. S. Government Printing Office, 1967, 434.

347. ________. Technology: Process of Assessment and Choice. Washington, D.C.: National Academy of Sciences, 1969, 163.

348. National Academy of Sciences and Social Science Research Council. The Behavioral and Social Sciences: Outlook and Need. Englewood Cliffs, New Jersey: Prentice-Hall, 1969, 320.

349. National Research Council. Technological Trends and National Policy. Washington, D.C.: National Research Council, 1937.

350. Nelson, Richard R., ed. The Rate and Direction of Inventive Activity: Economic and Social Factors. Princeton, New Jersey: Princeton University Press, 1962, 635.

351. North, Harper Q. Technological Forecasting in Industry. NATO, Defense Research Group Seminar, Technological Forecasting and Its Application to Defense Research, United Kingdom.

352. Ogburn, William F., et al. Technological Trends and National Policy, Including the Social Implications of New Inventions. Report of the Subcommittee on Technology to the National Resources Committee. Washington, D.C.: National Research Council, 1937, 388.

353. Ong, Walter J., ed. Knowledge and the Future of Man: An International Symposium. New York: Holt, Rinehart, and Winston, 1968, 276.

354. Organization for Economic Cooperation and Development. Energy Policy Problems and Objectives. Paris: OECD, 1966, 187.

355. ________. Perspectives of Planning. Paris: OECD, 1969, 527.

356. Ozbekhan, Hasan. Technology and Man's Future. Santa Monica, California: System Development Corporation, 1966, 41. (Report SP-2494)

357. Peccei, Aurelio. The Chasm Ahead. New York: Macmillan, 1968, 297.

358. Philipson, Morris, ed. Automation: Implications for the Future. New York: Vintage Books, 1962, 456.

359. Polak, Frederik L. The Image of the Future: Enlightening the Past, Orientating the Present, Forecasting the Future. Two Volumes. New York: Oceana, 1961, 456, 376.

360. ________. Prognostics: A Science in the Making Surveys and Creates the Future. Amsterdam: Elsevier, 1971, 425.

361. Poor, Riva, ed. 4 Days, 40 Hours: Reporting a Revolution in Work and Leisure. Cambridge, Massachusetts: Bursk and Poor, 1970, 175.

362. Prehoda, Robert W. Designing the Future--The Role of Technological Forecasting. Philadelphia: Chilton, 1967, 310.

363. ________. Extended Youth: The Promise of Gerontology. New York: Putnam, 1968, 256.

364. ________. Technological Forecasting Methodology. Pasadena: Electro-Optical Systems, 1966, 56.

365. Ramo, Simon. Century of Mismatch. New York: McKay, 1970, 204.

366. Rosenfeld, Albert. The Second Genesis: The Coming Control of Life. Englewood Cliffs, New Jersey: Prentice-Hall, 1969, 327.

367. Roslansky, John D., ed. Genetics and the Future of Man. New York: Appleton-Century-Crofts, 1966, 204.

368. Russell, Bertrand. The Future of Science. New York: Philosophical Library, 1959, 86.

369. ________. Icarus, or the Future of Science. London: Kegan Paul, 1924; New York: Dutton, 1926, 64.

370. Rutstein, David D. The Coming Revolution in Medicine. Cambridge, Massachusetts: M.I.T. Press, 1967, 180.

371. Ruzic, Neil P. Where the Winds Sleep: Man's Future on the Moon--A Projected History. Garden City, New York: Doubleday, 1970, 236.

372. Sarnoff, David, et al. The Fabulous Future: America in 1980. New York: Dutton, 1955, 206.

373. Schon, Donald A. Technology and Change: The New Heraclitus. New York: Delacorte, 1967, 248.

374. Schriever, Bernard A. and William W. Seifert. Air Transportation 1975 and Beyond: A Systems Approach. Cambridge, Massachusetts: M.I.T. Press, 1968, 516.

375. Schuster, Richard P., ed. The Next Ninety Years. Pasadena: California Institute of Technology, 1967, 186.

376. Seaborg, Glenn T. and William R. Corliss. Man and Atom: Building a New World Through Nuclear Technology. New York: Dutton, 1971, 411.

377. Still, Henry. Man: The Next 30 Years. New York: Hawthorn, 1968, 206.

378. Stulman, Julius. Evolving Mankind's Future. Philadelphia: Lippincott, 1967, 95.

379. Taylor, Gordon R. The Biological Time Bomb. New York: World, 1968, 240.

380. Taylor, John G. The Shape of Minds to Come. New York: Weybright and Talley, 1971, 278.

381. Theobald, Robert. An Alternative Future for America. Chicago: Swallow, 1968, 186.

382. Theobald, Robert; ed. Dialogue on Technology. New York: Bobbs-Merrill, 1967, 109.

383. Thomson, George P. The Foreseeable Future. Cambridge, England: Cambridge University Press, 1955, 166; Revised Edition, 1960, 145.

384. Udall, Stewart L. 1976: Agenda for Tomorrow. New York: Harcourt, Brace and World, 1968, 173.

385. U.S. Air Force. Aerospace Research Office. Long-Range Forecasting and Planning: A Symposium held at the United States Air Force Academy, Denver, Colorado, 16-17 August 1966. Alexandria, Virginia: Defense Documentation Center, 1967, 200.

386. U.S. Bureau of Labor Statistics. Technological Trends in Major American Industries. Washington, D.C.: U.S. Government Printing Office, 1966, 269.

387. U.S. Congress. House. Committee on Science and Astronautics. Establishing the Office of Technology Assessment and Amending the National Science Education Act of 1950. House Report 91-1437, 91st Congress, 2nd Session, September 9, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 26.

388. ________. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Government and Science No. 1: A Statement of Purpose. Report of the Subcommittee to the 88th Congress, 1st Session, December 2, 1963. Washington, D.C.: U.S. Government Printing Office, 1963, 14.

389. ________. Committee on Science and Astronautics. Subcommittee on Science Research and Development. Inquiries, Legislation, Policy Studies Re: Science and Technology; Review and Forecast. Second Progress Report of the Subcommittee to the 89th Congress, 2nd Session, October 17, 1966. Washington, D.C.: U.S. Government Printing Office, 1966, 28.

390. U.S. Congress. House. Committee on Science and Astronautics. A Technology Assessment System for the Executive Branch. Report prepared for the Committee by the National Academy of Public Administration, 91st Congress, 2nd Session, July 16, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 85.

391. ________. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Technology Assessment. Statement of Emilio Q. Daddario, Chairman of the Subcommittee to the 90th Congress, 1st Session, July 3, 1967. Washington, D.C.: U.S. Government Printing Office, 1967, 19.

392. ________. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Technology Assessment. Hearings before the Subcommittee to the 91st Congress, 1st Session, November 18, 24; December 2-4, 8, 12, 1969. Washington, D.C.: U.S. Government Printing Office, 1970, 501.

393. ________. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Technology Assessment: Annotated Bibliography and Inventory of Congressional Organization for Science and Technology. Report prepared for the Subcommittee by Genevieve J. Knezo and Dorothy M. Bates, 91st Congress, 2nd Session, July 15, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 92.

394. ________. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Technology Assessment, 1970. House Report 17046 of the Subcommittee to the 91st Congress, 2nd Session, March 13-June 3, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 1008. (Two Parts)

________. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. A Technology Assessment of the Vietnam Defoliant Matter - A Case History. Report prepared for the Subcommittee by the Science Policy Research Division, Library of Congress, 91st Congress, 1st Session, August 8, 1969. Washington, D.C.: U.S. Government Printing Office, 1969, 73.

396. ________. Committee on Science and Astronautics. Subcommittee on Science, Research, and Development. Technology Assessment Seminar. Proceedings before the Subcommittee to the 90th Congress, 1st Session, September 21-22, 1967. Washington, D.C.: U.S. Government Printing Office, 1967, 184.

397. U.S. Congress. House. Committee on Science and Astronautics. Subcommittee on Space Science and Applications. Assessment of Space Communications Technology. Report of..., 91st Congress, 1st Session, March 3, 1970. House Report 91-859. Washington, D.C.: U.S. Government Printing Office, 1970, 33.

398. ______. Committee on Science and Astronautics. Subcommittee on Space Science and Applications. Assessment of Space Communications Technology. Hearings before..., 91st Congress, 1st Session, December 17-19, 1969. Washington, D.C.: U.S. Government Printing Office, 1970, 249.

399. U.S. Congress. Senate. Committee on Small Business. Subcommittee on Science and Technology. Prospects for Technology Transfer. Report of..., 90th Congress, 2nd Session, May 1, 1968. Washington, D.C.: U.S. Government Printing Office, 1968, 19.

400. U.S. Federal Power Commission. National Power Survey. Two Volumes. Washington, D.C.: U.S. Government Printing Office, 1964, 296, 42[illegible].

401. U.S. National Commission on Technology, Automation, and Economic Progress. Technology and the American Economy. Washington, D.C.: U.S. Government Printing Office, 1966, Summary Volume plus 6 Appendices, 115, 373, 275, 151, 291, 309.

402. U.S. National Resources Committee. Technological Trends and National Policy--Including the Social Implications of New Inventions. A report of the Subcommittee on Technology, U.S. National Resources Committee. Washington, D.C.: U.S. Government Printing Office, 1937, 388.

403. U.S. Navy Technological Forecasting Group. Proposed Naval Technological Forecast. Final Report (unclassified version). Washington, D.C.: U.S. Navy Technological Forecasting Group, 1966, 174.

404. U.S. President's Materials Policy Commission. Resources for Freedom. Five Volumes. Washington, D.C.: U.S. Government Printing Office, 1952, 184, 210, 43, 228, 154.

405. University of Syracuse. Physical and Social Science Faculties. Science and Technology in the 1985 Era. Supplement to The United States and the World in 1985 Era. DDC Accession Number AD 613526. Syracuse, New York: Syracuse University Research Corporation, 1964.

406. Van Leeuwen, Arend T. Prophecy in a Technocratic Era. New York: Scribner's, 1968, 130.

407. Vickers, Geoffrey. Freedom in a Rocking Boat: Changing Values in an Unstable Society. London: Allen Lane, 1970, 215.

408. The Wall Street Journal, the Staff of, eds. Here Comes Tomorrow: Living and Working in the Year 2000. New York: Dow Jones, 1966, 196.

409. ________. The Innovators: How Today's Inventors Shape Your Life Tomorrow. New York: Dow Jones, 1968, 110.

410. Wallia, C.S., ed. Toward Century 21: Technology, Society, and Human Values. New York: Basic Books, 1970, 318.

411. Warner, Aaron W., Dean Morse, and Alfred S. Eichner, eds. The Impact of Science on Technology. New York: Columbia University Press, 1965, 221.

412. Warshofsky, Fred. The Twenty-First Century: The Control of Life. New York: Viking Press, 1969, 181.

413. Warshofsky, Fred, ed. The Twenty-First Century: The New Age of Exploration. New York: Viking Press, 1969, 177.

414. Wells, Herbert G. Anticipations of the Reaction of Mechanical and Scientific Progress upon Human Life and Thought. New York and London: Harper, 1902, 342.

415. Whyte, Lancelot L. Accent on Form: An Anticipation of the Science of Tomorrow. New York: Harper and Row, 1954, 198.

416. ________. The Next Development in Man. New York: Holt, 1958, 322.

417. Wills, Gordon, David Ashton, and Bernard Taylor, eds. Technological Forecasting and Corporate Strategy. London: Lockwood, 1969, 273.

418. Wolstenholme, Gordon E. W., ed. Man and His Future. London: Churchill, 1963, 409; Boston: Little, Brown, 1963, 409.

419. Young, Michael. Forecasting and the Social Sciences. London: Heinemann, 1968, 166.

420. Zwicky, Fritz. Morphology of Propulsive Power. Pasadena: Society for Morphological Research, 1962.

LEADING QUESTIONS

1. What are the distinctions between technological forecasting and assessment, and how are they related?

2. Who attempts to forecast technological development and why?

3. What is the difference between exploratory and normative forecasting? Are they mutually exclusive or reinforcing or neither? Is there a more valid way of understanding the modes of forecasting?

4. How may computers be used as tools of forecasting or assessment?

5. What are the merits of reproducible versus non-reproducible techniques, e.g., the Delphi technique? What are their strengths and weaknesses? For what kinds of problems are non-reproducible techniques most useful? Least useful?

6. What institutional arrangements have been suggested to improve the quality of technological forecasting and assessment?

7. What are the relationships between technological change and the socio-economic structure of society? Contrast or compare relationships under socialism, free enterprise, and traditional forms of society.

8. What are the possible roles for technological forecasting and assessment in public planning? Cite examples of how predictive approaches to technology have been used (e.g., 1937, National Research Council report), and analyze the validity of their assessments.

9. Has science fiction and Utopian literature had any measurable effect upon the history of technology? What have been the effects of forecasts appearing to be self-fulfilling or self-defeating?

10. Can the needs of society be identified and defined for optimal use of technological possibilities? If this could be done, what means would be employed?

TOPIC 14 SCIENCE, HUMAN RIGHTS, AND THE ROLE OF LAW

Science and technology change relationships among individuals, and between individuals and society. For example, biomedical knowledge has changed public attitudes toward various aspects of disease and has placed upon government new responsibilities for protecting the public welfare. New forms of information gathering, new techniques of crime detection, new pharmaceutical products, and new forms of energy and of industrial organization create problems of human rights and justice for which historical experience provides no adequate precedent. Moreover, the advancement of science sharpens debate over the meaning of "human rights" and the substance of "justice". Are "rights" and "justice" no more than social conventions, unsupported by any knowledge derived from science?

Law as a social institution is therefore under stress in attempting to accommodate traditional attitudes and assumptions to the realities of technoscientific society. Before the advent of science, law rested securely upon social or political "truth". In Medieval Europe, witchcraft was a legal fact validated by popular belief. When the growth of scientific knowledge undermined belief in witches, the laws punishing witchcraft ceased to be enforceable. Witchcraft had ceased to be a social or political truth. Law stabilizes and protects the established social order, and changes in the law reflect changes in society. But an accelerating rate of technoscientific change may exceed the capacity of social attitudes and institutions to make corresponding adjustments. The volume of law making, in the United States for example, has increased over the years largely (although often indirectly) because of the new factors introduced into society by science and technology. And yet the process of law revision does not keep pace with technoscientific change.

Several new fields of law or legal theory have emerged as a direct consequence of technoscientific innovation. Among these new areas for legal concern are atomic energy; exploitation of the oceans beyond national jurisdiction; exploration of outer space; genetic manipulation of human physiology; and psycho-chemical influences on human personality. In trying to cope with these and other problems of the technoscientific age, the law is increasingly compelled to take cognizance of scientific evidence. Even the voice of the people cannot make a scientific truth out of a political falsehood.

Means are needed to speed up the adaptation of law to conditions of the technoscientific age. Law revision commissions in several of the American state governments assist the technical updating of the law, but they are rarely, if ever, equipped to deal with the larger dimensions of the problem of technoscientific change. Some instrumentality for rapprochement of science and law is needed, not only in the United States, but in all technoscientifically advanced countries. Not only domestic national law but also international law must be clarified, revised, and expanded to guide new supra- or transnational enterprises. A deficiency of adequate legal concepts is today a deterring factor in the establishment of transnational agencies for management of the oceans and polar regions, and for the exploration of outer space. Thus science transforms the character of the law and forces it to expand its dimensions.

TOPIC 14 SCIENCE, HUMAN RIGHTS, AND THE ROLE OF THE LAW

Selected Basic Readings:

Baram, Michael S. "Social Control of Science and Technology," Science, CLXXII (May 7, 1971), 535-539.

D'Amato, Anthony A. "Environmental Degradation and Legal Action," Bulletin of the Atomic Scientists, XXVI (March, 1970), 24-26.

Meyers, David W. "Organ Transplantation and the Law," Impact, XXI (July-September, 1971), 223-232.

Tribe, Lawrence H. "Legal Frameworks for the Assessment and Control of Technology," Minerva, IX (April, 1971), 243-255.

Wheeler, Harvey. "Bringing Science under Law," Center Magazine, II (March, 1969), 59-67.

Supplementary and Substitute Readings:

Cavers, David F. "The Legal Control of the Clinical Investigation of Drugs: Some Political, Economic and Social Questions," Daedalus, XCVIII (Spring, 1969), 427-448.

Curran, William J. "Government Regulation of the Use of Human Subjects in Medical Research: The Approach of Two Federal Agencies," Daedalus, XCVIII (Spring, 1969), 542-594.

Estep, Samuel D. "International Lawmakers in a Technological World: Space, Communications, and Nuclear Energy," George Washington Law Review, XXXIII (October, 1964), 162-180.

Livingston, Dennis. "An International Law of Science: Orders on Man's Expanding Frontiers," Bulletin of the Atomic Scientists, XXIV (December, 1968), 6-10.

Loevinger, Lee. "Science and Legal Thinking," Federal Law Journal, XXV (Spring, 1965), 153-166.

Miller, Arthur S. "Science Challenges Law," American Behavioral Scientist, XIII (March-April, 1970), 585-593.

TOPICAL OUTLINE	REFERENCE KEY
I. Interactions between Science and Jurisprudence	13, 57, 79, 91, 92, 142
A. Traditional concepts of law: laws of nature and man-made laws	
1. Laws of nature: deductive, descriptive, value-free--Newton's laws of motion, Malthus' law of population growth	
2. Laws of men: inductive, normative, value expressive	50
B. Concepts of natural law	42, 107
1. Jus naturale in Roman law	
2. Christian theocratic concepts--laws of nature and of nature's God	
3. Physiocracy, biocracy, technocracy	
C. Science and positive law	64
1. Juridical truth versus scientific truth:	178
a. Statutory fiat	
b. Testimony in courts	127
c. Methods of crime detection and identification	55, 125
2. Legal rights in knowledge and invention	46, 52, 67, 152
a. Copyrights and patents--comparison between U.S. and U.S.S.R.	43, 101, 147, 149, 164, 179, 197
b. Government control over scientific and technological innovation in the interests of health, safety, public welfare, and morals	48, 105, 153, 188
c. Conflicts between rights to knowledge as property and advancement of science and education	56, 98, 123, 184, 198
D. Problems of interpretation	23, 59
1. Semantic difficulties and the substitution of processes and forces for the "law" concept in science	
2. Incompatibility of tests of "truth"	134
3. Value-relativity of normative laws	

II. Changing Concept of Human Rights	42, 89, 158, 171, 174
A. Concepts of "rights" changed by scientific or science-derived concepts	135, 157
1. Property ownership	
2. Contractual obligations	
3. Working conditions	36
4. Personal privacy	16, 62, 70, 89, 139, 140
5. Educational opportunity	
6. Ethno-racial attitudes	120
7. Environmental quality	18, 28, 187
B. Realization of theoretical "rights" made feasible by technoscience	157
1. Nourishment	
2. Medical services	25, 76, 83, 151
3. Mass education	
4. Gainful employment	36
C. Areas of impending change or development in law resulting from the growth of scientific knowledge	
1. Space law: a new phase of international law	3, 24, 44, 77, 84, 109, 110, 124, 146, 159, 160, 167, 170, 181
2. Resources on the ocean floor	104, 108, 114, 128, 148, 156, 157, 190
3. Shift from rights in property to rights in environment	81, 157, 162
4. Domestic relations and sex	
a. Social interposition in traditional family matters	113
b. Declining social interposition in adult sexual relations	
5. Sociopathic behavior	
a. Preventive detention and selective personality rehabilitation	186
b. Penology--treatment of criminal offenders	145
6. Experimentation	
a. Physical environment	132, 163, 175, 191

b. Human beings 1, 6, 26, 27, 72, 93

c. Ecological conditions 103, 157

7. Information and communication 5, 123, 164, 179, 197, 198

a. What may be communicated? Content and method

b. Rights to information and knowledge
(1) Patents, copyrights, contracts
(2) Public control of information

III. Science Reshaping the Law 7, 34, 54, 64, 79, 91

A. Amenability of law to scientific concepts and methods

1. Questions of law seldom directly amenable to science
a. Tax law
b. Corporation law.
c. Property law (in part)
d. Laws generally reflecting value judgments for which no empirical test is available

2. Laws subject to reshaping by science
a. Legal provisions for which empirical proof is relevant and admissible as evidence
b. Laws of which the underlying assumptions are destroyed by science, e.g., witchcraft

B. Incongruence of scientific facts and legal facts--selected issues 8, 86

1. Punishment as deterrent to crime
2. Intelligence and the voting age
3 Insanity as a legal concept
4. Legal status and scientific evidence concerning tobacco, alcohol, and marijuana 94, 206
5. Sexual behavior and legal proscription 38, 126
6. Death as a legal and scientific fact 33, 45, 96, 122

C. Confrontations of science, law, and policy (Cf. Topic 11) 12, 22, 58, 137, 138, 142

1. Impairment of the physical environment	18, 28, 66, 150, 157, 175, 187
a. Radioactive fallout	103, 130, 176, 205
b. Air pollution	196
c. Water pollution	35, 99, 104, 114, 148, 156
d. Noise	
e. Esthetic degradation	
f. Crowding	
g. Weather modification	163, 192
2. Biomedical technology	32, 177
a. Animal care	
b. Experiments on human subjects	10, 11, 15, 28, 72, 73
c. Prosthetic facilities	
d. Biological warfare	9, 14, 17, 47, 115, 193
e. Organ transplantation	31, 88, 111
f. Keeping patients physically "alive"	20
3. Public health	19, 25, 47
a. Control of drugs	41, 52, 69, 94
b. Flouridation of water supplies	85
c. Population control	45, 49, 61, 82, 121, 131
d. Cigarettes	
e. Side-effects of ethical drugs	53
4. Property rights in knowledge	63, 152, 200
a. Copyright laws, replication technique, and education	51
b. Restrictions on employment of research workers and inventors	168
c. Distribution of television frequencies and time	
d. Commercial profit from government-supported research	21
e. Government patent policy	67, 199, 200

IV. Scientific Legal Technology — 64, 117, 185

A. Does the introduction of science into legal technology protect, impair, clarify, or render irrelevant concepts of human rights, or are all of these effects possible?

B. Extension of scientific technique to legal research
   1. Indexing
   2. Computerization of legal data
   3. Analytic methods of social and behavioral science, and quantitative analysis

C. Continuing influence of scientific methods on philosophy of law and juridical action 64, 79

BIBLIOGRAPHY

General References: Articles

1. Alexander, Leo. "Limitations in Experimental Research on Human Beings," Lex et Scientia, III (January-March, 1966), 8-24.

2. ______. "Protection of Privacy in Behavioral Research," Lex et Scientia, IV (January-March, 1967), 34-38.

3. Anderson, Clarence P. "Outer Space Liability," Congressional Record, CXVII (July 30, 1971), S12676-S12679.

4. Andrews, John A. "Who Owns the Resources of the Sea?" New Scientist, XVIII (May 9, 1963), 307-309.

5. Bac[illegible]ch, Arthur J. "The Ethics of Tachistoscopy," Bulletin of the Atomic Scientists, XV (May, 1959), 212-215.

6. Ballard, Robert W. "Patient Consent in Experimental Drug Therapy," Lex et Scientia, I (January-March, 1964), 216-221.

7. Baram, Michael S. "Social Control of Science and Technology," Science, CLXXII (May 7, 1971), 535-539.

8. Barrow, Roscoe L. and Howard D. Faying. "Our Changing Epilepsy Laws," Lex et Scientia, II (January-March, 1965), 153-161.

9. Baxter, Richard R. and Thomas Buergenthal. "Legal Aspects of the Geneva Protocol of 1925," American Journal of International Law, LXIV (October, 1970), 853-879.

10. Beecher, Henry K. "Documenting the Abuses," Saturday Review, XLIX (July 2, 1966), 45-46.

11. ______. "Human Studies," Science, CLXIV (June 13, 1969), 1256-1258.

12. Beresford, Samuel M. "Lawyers, Science, and the Government," George Washington Law Review, XXXIII (October, 1964), 181-200.

13. Berns, Walter. "Law and Behavioral Science," Law and Contemporary Problems, XXVIII (Winter, 1963), 185-212.

14. Bioscience. "Secret Contract Research and the University," Bioscience, XVII (August, 1967), 524-526.

15. Bixler, Ray H. "Ostracize Them!" Saturday Review, XLIX (July 2, 1966), 47-48.

16. Bloustein, Edward J. "Privacy as an Aspect of Human Dignity: An Answer to Dean Prosser," New York University Law Review, XXXIX (December, 1964), 962-1007.

17. Bunn, George. "The Banning of Poison Gas and Germ Warfare: The U.N. Role," American Journal of International Law, LXIV (September, 1970), 194-199.

18. Carter, Luther J. "Environmental Pollution: Scientists Go to Court," Science, CLVIII (December 22, 1967), 1552-1556.

19. Cavers, David F. "The Legal Control of the Clinical Investigation of Drugs: Some Political, Economic, and Social Questions," Daedalus, XCVIII (Spring, 1969), 427-448.

20. Comfort, Alex. "The Prolongation of Vigorous Life," Impact, XX (October-December, 1970), 307-319.

21. Corner, Troy B. "The Licensing of Power and Testing Reactors in the United States," Lex et Scientia, III (January-March, 1966), 32-36.

22. Cranberg, Lawrence. "Law--Scientific and Juridical," American Scientist, LVI (Autumn, 1968), 244-253.

23. ________. "Science, Ethics, and Law," Zygon, II (September, 1967), 262-271.

24. Crane, Robert D. "The Beginning of Marxist Space Jurisprudence," American Journal of International Law, LVII (July, 1963), 615-625.

25. Cunningham, William C. "Indicated Blood Transfusions and the Adult Jehovah's Witness: Trial Judge's Dilemma," Valparaiso University Law Review, II (Fall, 1967), 55-83.

26. Curran, William J. "Government Regulation of the Use of Human Subjects in Medical Research: The Approach of Two Federal Agencies," Daedalus, XCVIII (Spring, 1969), 542-594.

27. Curran, William J. "Legal Codes in Scientific Research Involving Human Subjects," Lex et Scientia, III (April-June, 1966), 65-73.

28. D'Amato, Anthony A. "Environmental Degradation and Legal Action," Bulletin of the Atomic Scientists, XXVI (March, 1970), 24-26.

29. Doctors, Samuel [illegible] "Transfer of Space Technology to the American Consumer: The [illegible] of NASA's Patent Policy," Minnesota Law Review, LII (March, 1968), 789-818.

30. Doumani, George. "Science Policy for Antarctica," Bulletin of the Atomic Scientists, XXIV (April, 1968), 39-45.

31. Dukeminier, Jesse, Jr. and David Sanders. "Organ Transplantation: Proposal for Routine Salvaging of Cadaver Organs," New England Journal of Medicine, CCLXXIX (August 22, 1968), 413-419.

32. Edwards, Richard G. and Daniel J. Sharpe. "Social Values and Research in Human Embryology," Nature, CCXXXI (May 14, 1971), 87-91.

33. Ellner, Charles H. "Life and Death as Viewed by the Common Law," Lex et Scientia, IV (January-March, 1967), 15-23.

34. Estep, S. D. "International Lawmakers in a Technological World: Space, Communications, and Nuclear Energy," George Washington Law Review, XXXIII (October, 1964), 162-180.

35. Fay, James A. "Oil Spills: The Need for Law and Science," Technology Review, LXXII (January, 1970), 33-35.

36. Feingold, Victor. "Automation--A Dilemma in the United States," Lex et Scientia, II (January-March, 1965), 115-131.

37. Ficarra, Bernard J. "Artificial Insemination: A Medico-Legal Concern," Lex et Scientia, IV (January-March, 1967), 48-62.

38. ________. "Sex Problems in Law," Lex et Scientia, III (October-December, 1966), 228-240.

39. Florkin, Marcel. "Medical Experiments on Man," UNESCO Courier, XXI (March, 1968), 20-29.

40. Foster, Michael. "Vivisection," Scientific Monthly, LXXI (September, 1950), 139-146.

41. Fox, Renee C. "Some Social and Cultural Factors in American Society Conducive to Medical Research on Human Subjects," Clinical Pharmacology and Therapeutics, I (July-August, 1960), 423-444.

42. Frankena, William K. "Natural and Inalienable Rights," Philosophical Review, LXIV (April, 1955), 212-232.

43. Franko, Edward G. "Licensing Technology," Industrial Research, XI (August, 1969), 54-56.

44. Gardner, Richard N. "Outer Space: Problems of Law and Power," Department of State Bulletin, XLIX (September 2, 1963), 367-371.

45. Giannella, Donald A. "The Difficult Quest for a Truly Humane Abortion Law," Villanova Law Review, XIII (Winter, 1968), 257-302.

46. Gibbons, Gerald R. "Field Restrictions in Patent Transactions: Economic Discrimination and Restraint of Competition," Columbia Law Review, LXVI (March, 1966), 423-483.

47. Gibson, Stephen L. "Contemporary Practice of the United States Relating to International Law," American Journal of International Law, LXIV (April, 1970), 631-652.

48. Green, Harold P. "Nuclear Technology and the Fabric of Government," George Washington Law Review, XXXIII (October, 1964), 121-161.

49. Greep, Roy O. "Prevalence of People," Perspectives in Biology and Medicine, XXII (Spring, 1969), 332-343.

50. Hart, Herbert L. A. "Social Solidarity and the Enforcement of Morality," University of Chicago Law Review, XXXV (Autumn, 1967), 1-13.

51. Heilprin, Laurence B. "Technology and the Future of the Copyright Principle," American Documentation, XIX (January, 1968), 6-11.

52. Hesse, Eugene G. "A Discussion of the Current World-Wide Attack on the Patent System as It Particularly Affects the Pharmaceutical Industry," Lex et Scientia, I (January-March, 1964), 133-144.

53. Hindell, Keith and Madeleine Simms. "How The Abortion Lobby Worked," Political Quarterly, XXXIX (July-September, 1968), 269-282.

54. Jenks, C. Wilfred. "The New Science and the Law of Nations," International and Comparative Law Quarterly, XVII (April, 1968), 328-332.

55. Johnson, Marlin W. "Science and Law Enforcement: Partners in Progress," Journal of Forensic Science, X (January, 1965), 113-120.

56. Kaltenecker, H. "Practice and Policy of the European Space Research Organization (ESRO) Concerning Intellectual Property Rights, Access to and Disclosure and Use of Information," Lex et Scientia, IV (July-September, 1967), 156-164.

57. Kalven, Harry and Hans Zeisel. "Law, Science and Humanism," in The Humanist Frame, ed. by Julian Huxley. New York: Harper, 1961, 329-344.

58. Katz, Milton. "The Function of Tort Liability in Technology Assessment," The University of Cincinatti Law Review, XXXVIII (Fall, 1969), 587-662.

59. Kelsen, Hans. "Science and Politics," American Political Science Review, XLV (September, 1951), 641-661.

60. Kenny, John J. and Ronald P. Hrusoff. "The Ownership of the Treasures of the Sea," William and Mary Law Review, IX (Winter, 1967), 383-401.

61. Ketchel, Melvin N. "Fertility Control Agents as a Possible Solution to the World Population Problem," Perspectives in Biology and Medicine, XI (Summer, 1968), 687-703.

62. King, Donald B. "Electronic Surveillance and Constitutional Rights: Some Recent Developments and Observations," George Washington Law Review, XXXIII (October, 1964), 240-269.

63. Kirkpatrick, William W. "Antitrust in Orbit," George Washington Law Review, XXXIII (October, 1964), 89-120.

64. Korn, Harold N. "Law, Fact, and Science in the Courts," Columbia Law Review, LXVI (June, 1966), 1080-1116.

65. Krieger, Knut A. "Universities Must Engage in Secret Research," Industrial Research, IX (October 5, 1967), 80; 90-92.

66. Krier, James E. "The Pollution Problem and Legal Institutions: A Conceptual Overview," UCLA Law Review, XVIII (1971), 429-477.

67. Lambright, W. Henry. "Government, Industry, and the Research Partnership: The Case of Patent Policy," Public Administration Review, XXVIII (May-June, 1968), 214-221.

68. Langer, Elinor. "Human Experimentation: New York Verdict Affirms Patient's Rights," Science, CLI (February 11, 1966), 663-666.

69. Lasagna, Louis. "Problems of Drug Development," Science, CXLV (July 24, 1964), 362-367.

70. Law and Contemporary Problems. "Privacy," Law and Contemporary Problems, XXXI (Spring, 1966), 251-435 (entire issue).

71. Leach, W. Barton. "Meeting Ground of Law and Science in War: Operations Analysis in the USAAF, 1942-45," Lex et Scientia, II (January-March, 1965), 163-171.

72. Lear, John. "Do We Need New Rules for Experiments on People?" Saturday Review, XLIX (February 5, 1966), 61-70.

73. ________. "Experiments on People: The Growing Debate," Saturday Review, XLIX (July 2, 1966), 41-43.

74. ________. "Policing the Consequences of Science," Saturday Review, L (December 2, 1967), 65-67.

75. ________. "Whither Personal Privacy?" Saturday Review, XLIX (July 23, 1966), 36; 41; 67.

76. Lederberg, Joshua. "Some Problems of Instant Medicine," Saturday Review, L (May 6, 1967), 66-70.

77. Lissitzyn, Oliver J. "The American Position on Outer Space and Antarctica," American Journal of International Law, LIII (January, 1959), 126-131.

78. Livingston, Dennis. "An International Law of Science: Orders on Man's Expanding Frontiers," Bulletin of the Atomic Scientists, XXIV (December, 1968), 6-10.

79. Loevinger, Lee. "Science and Legal Thinking," Federal Law Journal, XXV (Spring, 1965), 153-166.

80. Luzzatto, Ettore. "The Proposed European Patent Convention and the Protection of Scientific Property," Lex et Scientia, III (July-September, 1966), 127-134.

81. McCaull, Julian. "Who Owns the Water?" Environment, XII (October, 1970), 31-39.

82. McElroy, William D. "Biomedical Aspects of Population Control," AIBS Bulletin (BioScience), XIX (January, 1969), 19-23.

83. McLeod, Raymond M. "Law, Medicine, and Public Opinion," Public Law (Summer, 1967), 107-128; Part II, Ibid. (Autumn, 1967), 185-211.

84. McMahon, John F. "Legal Aspects of Outer Space," British Yearbook of International Law, XXXVIII (1962), 339-399.

85. Margolis, Howard. "The Politics of Fluoridation," Bulletin of the Atomic Scientists, XX (June, 1964), 38-41.

86. Marshall, James. "Effect of Drugs and Blood Chemistry on Intent," Lex et Scientia, IV (July-September, 1967), 145-154.

87. Meenan, Patrick N. "The Human as a Research Subject," Lex et Scientia, III (January-March, 1966), 1-7.

88. Meyers, David W. "Organ Transplantation and the Law," Impact, XXI (July-September, 1971), 223-232.

89. Michael, Donald N. "Speculations on the Relation of the Computer to Individual Freedom and the Right to Privacy," George Washington Law Review, XXXIII (October, 1964), 270-286.

90. Mildvan, Albert S. "Secret Research Has No Place in a University," Industrial Research, I[illegible] (October 5, 1967), 87-89.

91. Miller, Arthur S. "Science Challenges Law," American Behavioral Scientist, XIII (March-April, 1970), 585-593.

93. ________. "Technology, Social Change, and the Constitution," George Washington Law Review, XXXIII (October, 1964), 17-46.

93. Miller, Arthur S. "Where Are the Lawyers?" Saturday Review, XLIX (July 2, 1966), 48-50.

94. Modell, Walter. "Mass Drug Catastrophes and the Roles of Science and Technology," Science, CLVI (April 21, 1967), 346-351.

95. Moor, Edgar J. "The International Impact of Automation," Lex et Scientia, IV (January-March, 1967), 10-14.

96. Morison, Robert S. "Death: Process or Event?" Science, CLXXIII (August 20, 1971), 694-698.

97. Mulford, Robert D. "Experiments on Human Beings," Stanford Law Review, XX (November, 1967), 99-117.

98. Munster, Joe H., Jr. and Justin C. Smith. "Savants, Sandwiches, and Space Suits," Science, CXLV (September 18, 1965), 1276-1281.

99. Nelson, Steven C. "Contemporary Practice of the United States Relating to International Law," American Journal of International Law, LXIV (October, 1970), 928-947.

100. Neumeyer, Fredrik. "The Employed Inventor--Part I: The European Situation," Lex et Scientia, II (January-March, 1965), 233-242.

101. ________. "The Employed Inventor--Part II: The American Situation," Lex et Scientia, II (January-March, 1965), 243-265.

102. Northrop, Filmer S. C. "Ethical Relativism in the Light of Recent Legal Science," Journal of Philosophy, LII (November 10, 1955), 649-662.

103. Novick, Sheldon. "The Burden of Proof," Environment, XII (October, 1970), 16-29.

104. O'Connell, Daniel P. "Legal Problems of the Exploitation of the Ocean Floor," Impact, XXI (July-September, 1971), 253-264.

105. Palfrey, John G. "Law and Science in Atomic Energy," Lex et Scientia, II (January-March, 1965), 218-231.

106. Parks, Larry G. and Stuart S. Dye. "Ocean Resource Development and Law of the Sea," Lex et Scientia, III (April-June, 1966), 107-116.

107. Pascal, Robert A. "Natural Law and Respect for Law," American Journal of Comparative Law, XV (Number 3, 1966-1967), 500-506.

108. Pell, Clarence. "Seabed Resources," Congressional Record, CXVI (December 19, 1970), S20787-S20788.

109. Pepin, Eugene. "Space Flight and the Rule of Law," UNESCO Courier, XIX (May, 1966), 17-18, ~~35-37~~.

110. ________. "Space Law (II): Legal Aspects of Direct Broadcasting by Satellite," Impact, XXI (July-September, 1971), 243-251.

111. Petrov, Rem. "Organ Transplantation: Problems and Perspectives," Impact, XX (October-December, 1970), 293-305.

112. Piel, Gerard. "Science, Censorship, and Public Interest," Science, CXXV (April 26, 1957), 792-794.

113. Polier, Justine W. "Problems Involving Family and Child," Columbia Law Review, LXVI (February, 1966), 305-3[illegible].

114. Purrett, Lawrence. "The Politics of Marine Research," Science News, XCIX (January 2, 1971), 9-11.

115. Rosebury, Theodor. "Some Historical Considerations," Bulletin of the Atomic Scientists, XVI (June, 1960), 227-236.

116. Ruebhausen, Oscar and Orville G. Brim, Jr. "Privacy and Behavioral Research," Columbia Law Review, LXV (November, 1965), 1184-1211.

117. Schur, Edwin M. "Scientific Method and the Criminal-Trial Decision," Social Research, XXV (Summer, 1958), 173-190.

118. Science. "Medical Ethics: British Unit Offers Guidelines for Research Involving Human Subjects," Science, CXLV (September 4, 1964), 1024-1025; 1080-1084.

119. ________. "The Problem of Experimentation on Human Beings," Science, CXVII (February 27, 1953), 205-215.

120. ________. "Racial Studies: Academy States Position on Call for New Research," Science, CLVIII (November 17, 1967), 892-893.

121. Segal, Sheldon J. "Research in Fertility Regulation," New England Journal of Medicine, CCLXXIX (August 15, 1968), 364-370.

122. Shaffer, Thomas L. "Abortion, the Law, and Human Life," Valparaiso University Law Review, II (Fall, 1967), 94-106.

123. Sheniti, S. Mahmud. "Multiple Reproduction Processes and Authors' Rights," Impact, XXI (July-September, 1971), 271-278.

124. Sibiryakov, G. "Real Aims of U.S. Space Co-operation," International Affairs (Moscow) Number 2 (February, 1966), 62-65.

125. Sinclair, P. Michael. "New Technology for Crime Fighting," Industrial Research, IX (November 5, 1967), 84-90.

126. Smith, Alexander B. and Harriet Pollack. "Crimes without Victims," Saturday Review, LIX (December 4, 1971), 27-29.

127. Smith, Burke M. "The Polygraph," Scientific American, CCXVI (January, 1967), 25-31.

128. Stevenson, Johnathan R. "Legal Regulation of Mineral Exploitation in the Deep Seabed," U.S. Department of State Bulletin, LXV (July 12, 1971), 48-55.

129. Stewart, William H. "An Invitation to Open Debate," Saturday Review, XLIX (July 2, 1966), 43-44.

130. Strohl, Pierre. "The Role of ENEA in the Field of Nuclear Law," OECD Observer, Number 38 (February, 1969), 38-42.

131. Szabady, Egon. "The Legalizing of Contraceptives and Abortions," Impact, XXI (July-September, 1971), 265-270.

132. Taubenfeld, Howard J. "Weather Modification and Control: Some International Legal Implications," California Law Review, LV (May, 1967), 493-506.

133. Taylor, Carl E. "Ethics for an International Health Profession," Science, CLIII (August 12, 1967), 716-720.

134. Thomas, Richard K. "Judging Scientific Fact in Pharmaceutical Advertising," Lex et Scientia, III (October-December, 1966), 212-215.

135. Tobriner, Matthew O. and Joseph R. Grodin. "The Individual and the Public Service Enterprise in the New Industrial State," California Law Review, LV (November, 1967), 1247-1283.

136. Topol, Allan J. "Law and the Nation," Saturday Review, LI (August 3, 1968), 49-52.

137. Tribe, Lawrence H. "Legal Frameworks for the Assessment and Control of Technology," Minerva, IX (April, 1971), 243-255.

138. ________. "Towards a New Technological Ethic: The Role of Legal Liability," Impact of Science on Society, XXI (July-September, 1971), 215-222.

139. Westin, Alan F. "Science, Privacy, and Freedom: Issues and Proposals for the 1970's. Part I: The Current Impact of Surveillance on Privacy," Columbia Law Review, LXVI (June, 1966), 1002-1050.

140. ________. "Science, Privacy, and Freedom: Issues and Proposals for the 1970's. Part II: Balancing the Conflicting Demands of Privacy, Disclosure, and Surveillance," Columbia Law Review, LXVI (November, 1966), 1205-1253.

141. Whale, Arthur R. "Securing the Benefits of Science for Human Welfare," Lex et Scientia, II (January-March, 1965), 77-85.

142. Wheeler, Harvey. "Bringing Science under Law," Center Magazine, II (March, 1969), 59-67.

143. Willig, Sidney H. "The Control over Interstate Distribution and Use of Investigational Drugs," Lex et Scientia, IV (April-June, 1967), 110-119.

144. Wolfensberger, Wolf. "Ethical Issues in Research with Human Subjects," Science, CLV (January 6, 1967), 47-51.

145. Wright, J. Skelly. "The Need for Education in the Law of Criminal Correction," Valparaiso University Law Review, II (Fall, 1967), 84-93.

146. Zhukov, G. P. "Space Law (I): The New Extra-Terrestrial Jurisprudence," Impact, XXI (July-September, 1971), 233-241.

General References: Books

147. Alderson, Wroe, ed. Patents and Progress: The Sources and Impact of Advancing Technology. Homewood, Illinois: Richard D. Irwin, 1965, xiii, 251. Biblio.

148. Alexander, Lewis M., ed. The Law of the Sea. Columbus: Ohio State University Press, 1969, 321.

149. Bachman, Otto, Frederick M. Sherer, et al. Patents and the Corporation: A Report on Industrial Technology under Public Policy. Second Edition. Boston: Patents and the Corporation, 1959, 195.

150. Baldwin, Malcolm F. and James K. Page, eds. Law and the Environment. New York: Walker, 1970, 432.

151. Bear, Larry A. Law, Medicine, Science, and Justice. Springfield, Illinois: Charles C. Thomas, 1964, 656.

152. Berle, Alfred K. and L. Sprague de Camp. Inventions, Patents, and Their Management. Princeton, New Jersey: Van Nostrand, 1959, 602.

153. Bloustein, Edward J., ed. Nuclear Energy, Public Policy, and the Law. Dobbs Ferry, New York: Oceana, 1964, 114.

154. Bryan, William J., Jr. Legal Aspects of Hypnosis. Springfield, Illinois: Charles C. Thomas, 1962, 304.

155. Burke, William T. International Legal Problems of Scientific Research in the Oceans. Columbus: Ohio State University Press, 1967, 143.

156. ________. Towards a Better Use of the Ocean: Contemporary Legal Problems in Ocean Development. New York: Humanities Press, 1969, 231.

157. Caldwell, Lynton K. In Defense of Earth. Bloomington, Indiana: Indiana University Press, 1972, 293.

158. Casserly, Julian V. L. In the Service of Man: Technology and the Future of Human Values. Chicago: Regnery, 1967, 204.

159. Christol, Carl Q. International Law Studies 1962: The International Law of Outer Space. Washington, D.C.: U.S. Government Printing Office, 1966, 513.

160. Cohen, Maxwell, ed. Law and Politics in Space: Specific and Urgent Problems in the Law of Outer Space. Montreal, Canada: McGill University Press, 1964, 221.

161. Cohn, Simon I. Law Enforcement Science and Technology II. Pikesville, Maryland: Port City Press, 1969, 612.

162. Dobzhansky, Theodosius. The Biological Basis of Human Freedom. New York: Columbia University Press, 1956, 139.

163. Ellert, Robert B. Legal Aspects of Weather Modification. Paper presented at the 1967 Meeting of the American Association for the Advancement of Science, New York, December 30, 1967. New York: American Association for the Advancement of Science, 1967, 13.

164. Forman, Howard I. Patents: Their Ownership and Administration by the United States Government. New York: Central Book Co., 1957, 351.

165. Freed, J. Arthur. Some Ethical and Social Problems of Science and Technology: A Bibliography of the Literature from 1955. Los Alamos: Los Alamos Scientific Laboratory, University of California, 1964, 48.

166. Fuller, Lou L. The Morality of Law. New Haven, Connecticut: Yale University Press, 1964, 202.

167. Gal, Gyula. Space Law. Dobbs Ferry, New York: Oceana, 1969, 320.

168. Gellhorn, Walter. Security, Loyalty, and Science. Ithaca, New York: Cornell University Press, 1950, 300.

169. Ginsberg, Morris. On Justice in Society. Ithaca, New York: Cornell University Press, 1965, 248.

170. Haley, Andrew G. Space Law and Government. New York: Appleton-Century-Crofts, 1963, 584.

171. Hall, Cameron P., ed. Human Values and Advancing Technology. New York: Friendship Press, 1967, 175.

172. Hook, Sidney, ed. Determinism and Freedom in the Age of Modern Science: A Philosophical Symposium. New York: New York University Press, 1958, 237.

173. Hutton, Gerald L. Legal Considerations on Ionizing Radiation: Radionuclides and Radiation-Emitting Devices. Springfield, Illinois: Charles C. Thomas, 1966, 108.

174. Jones, Harry W. Law and the Social Role of Science. New York: Rockefeller University Press, 1966, 243.

175. Krier, James E. Environment Litigation and the Burden of Proof. Los Angeles: Institute of Government and Public Affairs, University of California, 1971, 18.

176. Krogen, Adrian A. Symposium on Atomic Energy and the Law. Berkeley: University of California, 1958, 125.

177. Meyers, David W. The Human Body and the Law: A Medico-Legal Study. Chicago: Aldine, 1970, 203.

178. Murphy, Walter F. Wiretapping on Trial: A Case Study in the Judicial Process. New York: Random House, 1965, 176.

179. National Academy of Sciences. National Academy of Engineering. Committee on Interplay of Engineering with Biology and Medicine. Government Patent Policy. Report of the Subcommittee. Washington, D.C.: National Academy of Engineering, 1970, 83.

180. National Academy of Sciences - National Research Council. Administration of Medical and Pharmaceutical Patents. Washington, D.C.: National Academy of Sciences - National Research Council, 1955, 69.

181. National Aeronautics and Space Administration. Conference on the Law of Space and of Satellite Communications. Washington, D.C.: Scientific and Technical Information Division, National Aeronautics and Space Administration, 1964, 205.

182. Northrop, Filmer S. C. The Complexity of Legal and Ethical Experience: Studies in the Method of Normative Subjects. Boston: Little, Brown, 1959, 331.

183. Packard, Vance. The Hidden Persuaders. New York: McKay, 1957, 275.

184. Palmer, Archie M. University Research and Patent Policies, Practices, and Procedures. Washington, D.C.: National Academy of Sciences - National Research Council, 1962, 291. (Publication 999)

185. Patterson, Edwin W. Law in a Scientific Age. New York: Columbia University Press, 1963, 87.

186. Roche, Philip Q. The Criminal Mind: A Study of Communication between the Criminal Law and Psychiatry. New York: Wiley, 1967, 311. (Reprint of 1958 Edition).

187. Sax, Joseph L. Defending the Environment: A Strategy for Citizen Action. New York: Knopf, 1971, 259.

188. Shils, Edward A. The Torment of Secrecy: The Background and Consequences of American Security Policies. Glencoe, Illinois: Free Press, 1956, 238.

189. Shindell, Sidney. The Law in Medical Practice. Pittsburgh: University of Pittsburgh Press, 1966, 297.

190. Slouka, Zdenek J. International Custom and the Continental Shelf: A Study in the Dynamics of Customary Rule of International Law. The Hague: Martinus Nijhoff, 1968, 186.

191. Taubenfeld, Howard J., et al. Weather Modification: Law, Controls, Operations. Report to the Special Commission on Weather Modification. National Science Foundation. Washington, D.C.: U.S. Government Printing Office, 1966, 73.

192. Taubenfeld, Howard J., ed. Weather Modification and the Law. Dobbs Ferry, New York: Oceana, 1968, 228.

193. Thomas, Ann V. W. and Adrian J. Thomas, Jr. Legal Limits on the Use of Chemical and Biological Weapons. Dallas, Texas: Southern Methodist University Press, 1970, 332.

194. Thorwald, Jurgen. Crime and Science. New York: Harcourt, Brace, and World, 1967, 494.

195. United Nations Educational, Scientific, and Cultural Organization. Human Rights, Comments and Interpretations: A Symposium. London: Allan Wingate, 1949, 287.

196a. U.S. Atomic Energy Commission. Planning for Environmental Protection in Siting of Nuclear and Fossil Fuel Power Plants. Remarks before Federal Bar Association, Atomic Energy Law Committee at a Seminar on Possible New Issues in AEC Licensing Proceedings, Antitrust and Environmental Effects, October 15, 1969, Washington. Washington, D.C.: U.S. Government Printing Office, 1969, 17.

197. U.S. Congress. Senate. Committee on the Judiciary. Subcommittee on Patents, Trademarks and Copyrights. An Economic Review of the Patent System. Study of the Subcommittee to the 85th Congress, 2nd Session, June 30, 1958. Pursuant to Senate Resolution 236, Study No. 15 prepared by Fritz Machlup. Washington, D.C.: U.S. Government Printing Office, 1958, 89.

198. ________. Committee on the Judiciary. Subcommittee on Patents, Trademarks, and Copyrights. The Impact of the Patent System on Research. Study of the Subcommittee to the 85th Congress, 2nd Session, May 16, 1958. Pursuant to Senate Resolution 236, Study No. 15 prepared by Seymour Melman. Washington, D.C.: U.S. Government Printing Office, 1958, 62.

199. U.S. Federal Council for Science and Technology. Office of Science and Technology. Annual Report on Government Patent Policy. Washington, D.C.: U.S. Government Printing Office, 1968, 64.

200. ________. Office of Science and Technology. Government Patent Policy Study. Final Report, Volume I. Washington, D.C.: U.S. Department of Commerce; Boston: Harbridge House, 1968, 57.

201. U.S. President's Commission on the Patent System. To Promote the Progress of . . . Useful Arts in an Age of Exploding Technology. Report of the President's Commission on the Patent System. Washington, D.C.: U.S. Government Printing Office, 1966, 58.

202. Weinstein, Jerry L., ed. Law and Administration. New York: Pergamon, 1966, 426. (Progress in Nuclear Energy Series, Volume 4)

203. Wilson, O. J. Patent and Copyright Policies in Forty-Five Colleges and Universities. Bowling Green: Office of Institutional Research, Western Kentucky University, 1967.

204. Woodling, George V. Inventions and Their Protection. Second Edition. New York: Boardman, 1954, 490.

205. World Health Organization. Protection against Ionizing Radiations: A Survey of Existing Legislation. Reprint from the International Digest of Health Legislation, XV (Number 2, 1964), 170.

206. ________. Treatment of Drug Addicts: A Survey of Existing Legislation. Reprint from the International Digest of Health Legislation, XIII (Number 1, 1962), 46.

LEADING QUESTIONS

1. What has been the net effect of science on belief in human rights--positive, negative, or neutral? What is the evidence?

2. Have efforts to discover a natural (or scientific) basis for positive law been naive, misguided, or premature? Have the difficulties been informational, perceptual, or institutional?

3. What are the legal and moral implications of advances in medical technology which make it possible to keep alive for considerable periods patients who may have suffered irreparable brain damage?

4. If we postulate a situation in which a "scientific truth" and a "political truth" are in conflict in society, which truth should prevail? In what respects are the assumptions of science and democracy mutually reinforcing? --potentially antagonistic?

5. With the availability and prospective application of new instruments of control over society, how can traditional concepts of freedom under law have meaning?

6. How far is it possible or desirable for government to control the use of electronic or other "spying" devices? Is privacy a human right? What is the evidence?

7. What "new rights" have been made feasible by science and what traditional rights have been modified or impaired? Is the very concept of "human rights" inconsistent with a scientific outlook?

8. What basic differences in attitudes concerning the economic and social [illegible]s of scientific and technological innovation are reflected in U.S. and U.S.S.R. patent laws?

9. To what extent must the scientist bear moral responsibility for the uses made of his innovation by society (in his own country or in a foreign country)? Could or should scientists band together in refusal to work in certain harmful areas of knowledge (e.g., nuclear weapons, germ warfare)?

10. What evidence might be cited for present or approaching changes in influence by scientific knowledge in the following areas:
    a. Property rights
    b. Sociopathic behavior
    c. Public health (e.g., sanitation, innoculation, flouridation)
    d. Publication, printing, broadcasting, etc.
    e. Medical, psychological, and social experimentation
    f. Domestic relations

TOPIC 15 GOVERNING THE TECHNOSCIENTIFIC SUPERCULTURE

One effect of science and technology upon modern society has been to create a new level of assumptions, values, methods, and information that transcends national and traditional cultural boundary lines. This level of awareness (or of knowledge) corresponds in some respects to the phenomenon that V. I. Vernadsky and Pierre Teilhard de Chardin called the "noösphere". Perhaps it is more because it includes material objects and social institutions as well as inanimate ideas. It is here described as the technoscientific superculture, not because it is necessarily superior to traditional cultures, but because it is a new cultural level overlaying geographically localized historical societies.

As noted under Topic 14 (Science, Human Rights, and the Role of Law), the inability of legal and judicial institutions to adjust to changing conditions is one of the major policy problems of the technoscientific age. In traditional societies where law could be relatively static, government could be largely a process of adjudication. In a technoscientific society, however, the tasks of government are increasingly managerial. The type of law which best serves as a foundation for public management is not always the same as that intended as a basis for the judgment of courts. A new structure of public accountability is required if society is to benefit fully from science and technology, and is to avoid both the tyranny of the technocrat and frustration from obsolete legal strictures.

The challenge of the technoscientific superculture to management is at least three-fold. The primary challenge is conceptual. It is to identify the needs of a viable industrial society, and the means to meet them, without impairing the ecological basis of that society or of human welfare generally. In the second place, the task of management is one of institutional development. The advancement of science and technology has resulted, often indirectly, in problems new in kind or magnitude for which traditional machinery of government does not suffice. Exploration of outer space has been one of these, and the control of environmental pollution and the universal extension of health care are policy areas that have yet to find adequate institutional expression. The third challenge is one of human development. To manage the forces liberated through science requires public officials and administrators with qualities rarely evident in the past. The stakes for success and failure in the superculture are too high to leave the quality of leadership in policy and management to chance. Ways must be found to provide society with leadership competence in the right places at the right times. This is largely a new task of higher education in which government, industry, the professions, and the universities must collaborate. Concomitant with this task is the upgrading of public understanding of science and technology, so that true reciprocity and responsibility can prevail between the roles of scientist and citizen and between both of these and the leadership in policy and management of the technoscientific superculture.

TOPIC 15 GOVERNING THE TECHNOSCIENTIFIC SUPERCULTURE

Selected Basic Readings:

Brooks, Harvey. "What Can Technology Do About Technology?" Research Management, XIV (March, 1971), 12-20.

Caldwell, Lynton K. "Managing the Scientific Super-Culture: The Task of Educational Preparation," Public Administration Review, XXVII (June, 1967), 128-133.

Gershinowitz, Harold. "National Differences in Styles of Research Management," Research Management, XII (May, 1969), 205-218.

Lakhtin, George A. "Operational Research Methods in the Management of Scientific Research," Minerva, VI (Summer, 1968), 524-540.

Randers, Jørgen and Donnella Meadows. "The Carrying Capacity of the Globe," Sloan Management Review, XIII (Winter, 1972), 11-27.

Supplementary and Substitute Readings:

Beer, Stafford. "Managing Modern Complexity," Futures, II (June, 1970), 114-122.

Bush, Vannevar. "Of Inventions and Inventors," Research Management, XIV (July, 1971), 27-36.

Feinberg, Mortimer R. "Fourteen Suggestions for Managing Scientific Creativity," Research Management, XI (March, 1968), 83-92.

Johnson, Howard W. "Education for Management and Technology in the 1970's," Science, CLX (May 10, 1968), 620-627.

Merton, Robert K. "Behavior Patterns of Scientists," American Scientists, LVII (Spring, 1969), 1-23.

Utterback, James M. "The Process of Technological Innovation Within the Firm," Academy of Management Journal, XIV (March, 1971), 75-88.

TOPICAL OUTLINE	REFERENCE KEY
I. Demands of the New Science and Technology upon Management	3, 97, 111, 150, 159, 172, 174, 206, 239
A. Information: high-level demand for extensive, accurate, and timely data	6, 68, 105, 151, 201
B. Interlocution: intermediary communication among specialists and diverse interest groups	87, 95, 155, 156, 198
C. Prescience: ability to detect trends and to predict developments (Cf. Topic 13)	13, 17, 203
D. Adaptability: capacity to respond to rapid changes in technology and the environment	3, 27
E. Versatility: tolerance for complexity and multi-focused problem-solving	87
II. Impact of Science and Technology upon Managerial Concepts and Practices	4, 46, 89, 150, 174, 184, 225, 231, 259, 261, 266, 281, 286, 294
A. "Scientific management"	114, 123, 197, 227, 246, 258
1. Frederick W. Taylor and the search for the "one best way"	171, 291
2. Efforts to develop a rational, prescriptive, "scientific" practice of management	46, 47, 132
3. Internationalization of the scientific management movement	88, 92, 96, 121, 126, 131, 145, 274, 303
B. Industrial psychology and organizational behavior	40, 52, 143

1. The Hawthorne experiments	56, 276
2. Human relations and group dynamics research	197, 245
3. Growth of personnel administration in government and industry	245, 276
C. Factors affecting the creativity of scientists and engineers	24, 35, 50, 51, 62, 75, 77, 93, 95, 117, 127, 130, 141, 144, 149, 155, 156, 162, 166, 196, 250, 257, 267, 270, 277
1. Organizational structure	3, 10, 41, 61, 115,
2. Intellectual capability	39, 109, 160
3. Age and physical condition	
4. Rewards and recognition	8, 21, 28, 29, 33, 69, 70, 104, 136, 139
5. Popularity of area of work	48
6. Personal motivation	22, 39, 54, 67, 95, 140
7. Pressure to be productive	64, 138
8. Freedom to do work of own interest	124
9. Patent policy and contract restrictions	23, 218, 296
10. Exceptional psychological factors	15, 81, 118
D. Operations research and "management science"	44, 91, 94, 119, 193, 195, 215, 246, 254, 268, 278, 282, 292
1. Efforts to cope with organizational size and complexity through quantitative analysis and mathematics	52, 158, 212
2. Objective: to study the management process scientifically, rather than to attempt to make the practice of management a science	36, 101
3. Product: a new kind of specialist—the systems analyst, advisory or auxiliary to traditional management	59, 65, 79, 122, 168

E. Scientific concepts injected into management theory and practice	11, 45, 100, 102, 125, 143, 148
1. Systems theory influence on organizational structure and managerial control	63, 83, 108, 129, 181, 186, 191, 246, 249, 253
2. Probability theory influence on actuarial forecasting and organizational decision-making	119, 223
3. Communications theories influence on management-employee information practices and communication with organizational clientele and the public	180, 272
4. Psychology of personality influences on selection and placement of personnel and use of standardized tests and performance ratings	31, 32, 64, 223
III. Science-Derived Tools of Managerial Operations, Analysis, and Decision-Making	27, 157, 231, 233, 284
A. Hardware--examples	43, 132, 222
1. Office machines	
2. Communications media	241, 272
3. Computers	6, 16, 76, 78, 105, 113, 161, 209, 283
B. Software--examples	91, 182, 238
1. Records management systems	241
2. Personnel management systems	135
3. Accounting and inventory systems	103, 151
4. Budget, planning, programming systems	12, 103, 264, 300
5. Operations control systems (e.g., PERT)	83, 252, 262
6. Models and simulation	1, 55, 92, 128, 194, 243, 292
IV. Educational Implications for Management in a Technoscientific Superculture	26, 82, 147, 203, 280, 304

A. Necessity for a continuous process of education — 71, 72, 97
   1. Omnipresent threat of obsolescence
   2. Preparatory education must be fundamental, not ephemeral
   3. Periodic up-grading through "executive development" experiences is essential

B. Cultural orientation required for effective managerial leadership — 5, 30, 235
   1. Manager must be able to operate in two cultures: traditional and technoscientific — 13, 234
   2. Educational experience ought, therefore, to provide appreciation of the full range of the cultural environment: humanistic, scientific, technical, political — 131

C. Better means are needed to increase the probability of managerial positions being filled by persons with qualities best suited to the demands of the new technoscientific society — 26, 82
   1. Qualities that impel individuals into top political, administrative, and managerial positions are not necessarily those that the responsibilities of the positions require
   2. Primitive attitudes may gain exaggerated harmfulness in a highly interdependent technoscientific society
   3. A reliable psychology of motivation is greatly needed for the improvement of politics and administration and for the task of educational preparation for the management of science and technology

V. Some Problems of Management in the Technoscientific Superculture (Micro-Administration) — 189, 190, 208, 212, 217, 219, 226, 239, 248, 282, 284, 298

A. Optimization and sub-optimization	53, 155, 156, 169, 200, 251
1. Ascertaining point of satisfactory accomplishment (Simon's "satisfycing")	
2. Calculation of costs and benefits at alternative levels of accomplishment and through alternative methods	12, 58, 103, 134, 170
3. Investigation of possible inadvertent and indirect consequences	42, 213, 214
a. Recourse to systems analysis	99, 111, 137, 142, 179, 181, 191, 192, 268, 269, 278, 297
b. Use of simulation	55, 85, 128
B. Organization of complex operations within a critical time dimension (initially exemplified in military operations and now extended to industrial production, outer-space exploration, and biomedical technology)	52, 79, 86, 165, 249, 255
1. Monolithic versus federalized (contractual organization)	216
2. Combination of authority and specialized competence: functional, program, and project management	57, 84, 177, 238
3. Control systems: timing, coordination, quality of performance	4, 112
4. Stand-by auxiliary facilities	120
5. Organizational tasks of simplification, refinement, and phase-out	120
C. Organizational cybernetics: steering the organization through its task environment	9, 83, 128, 202, 262
1. Surveillance and mapping of the task environment	
2. Interpretation of the significance of environmental interactions	
3. Development of feed-back and early warning systems and automatic response mechanisms	

VI. Policy Problems of Managing the Technoscientific Superculture (Macro-Administration)	18, 19, 74, 85, 86, 175, 183, 216, 304
A. Ascertaining the goals and priorities toward which the resources of the technoscientific society should be directed (Cf. Topics 11 and 12)	26, 66, 176, 271, 289, 301
B. Control of technology in the public interest (Cf. Topic 14)	7, 38, 89, 90, 188, 256
1. Reformulation of the public interest in the results of technological change	207, 272
2. Instrumental means for control of technological change	150, 269, 289
C. Resolving the conflict inherent in differences between the autonomy of technoscientific institutions and the values of democratic self-government	207, 216
1. Query: Are there inherent conflicts between science, technology, and democracy, or only between certain concepts and interpretations?	7, 187
2. Examination of the rationale for prevailing organization for science and technology	121, 216, 271
3. Development of an integrative concept of social control to assist the harmonization of scientfiic truth, technological advantage, and democratic responsibility	17, 146
4. Necessity for administrative leadership in the integrative task	7, 26, 30, 106, 289

BIBLIOGRAPHY

General References: Articles

1. Abt, Clark C. "Playtime in the Boardroom--A New Educational Technology," European Business, Number 30 (Summer, 1971), 54-63.

2. Asmutz, Arnold E. "City Management--A Problem in Systems Analysis," Technology Review, LXXI (October-November, 1968), 47-53.

3. Anderson, Arthur G. "Maintaining Vitality in R & D Organizations," Research Management, XIV (July, 1971), 47-57.

4. Arrow, Kenneth J. "Control in Large Organizations," Management Science, X (April, 1964), 397-408.

5. Ashby, Eric. "The Administrator: Bottleneck or Pump?" Daedalus, XCI (Spring, 1962), 264-278.

6. Baker, W. O. "Computers as Information-Processing Machines in Modern Science," Daedalus, XCIX (Fall, 1970), 1088-1120.

7. Beard, Charles A. "Government by Technologists," New Republic, LXIII (June 18, 1960), 115-120.

8. Beebe, Thomas H. "Company Practices in Rewarding Outstanding Research Achievements," Research Management, VIII (September, 1965), 311-329.

9. Beer, Stafford. "Managing Modern Complexity," Futures, II (June, 1970), 114-122.

10. Ben-David, Joseph. "Scientific Productivity and Academic Organization in Nineteenth-Century Medicine," American Sociological Review, XXV (December, 1960), 828-843.

11. Blake, Robert R., Jane Mouton, Louis B. Barnes, and Larry E. Greiner. "Breakthrough in Organization Development," Harvard Business Review, XLII (November-December, 1964), 133-155.

12. Bobis, A.H., T.F. Cooke, and J.H. Paden. "A Funds Allocation Method to Improve the Odds for Research Successes," Research Management, XIV (March, 1971), 34-49.

13. Boettinger, Henry M. "Technology in the Manager's Future," Harvard Business Review, XLIX (November-December, 1970), 4-14, 165.

14. Bondi, A. "Focusing on a Single Objective: A Contribution of Applied Research to Science and Engineering Methodology," Chemical Technology, (October, 1971), 592-598.

15. Boring, Edwin G. "Psychological Factors in the Scientific Process," American Scientist, XLII (October, 1954), 639-645.

16. Brabb, George J. and Earl B. Hutchins. "Electronic Computers and Management Organization," California Management Review, VI (Fall, 1963), 33.

17. Bright, James R. "Opportunity and Threat in Technological Change," Harvard Business Review, XLI (November-December, 1963), 76-86.

18. Brooks, Harvey. "Models for Science Planning," Public Administration Review, XXXI (May-June, 1971), 364-374.

19. ________. "What Can Technology Do About Technology?" Research Management, XIV (March, 1971), 12-20.

20. Brough, Bryan M. "Operational Research as a Staff Service to Management," Operational Research Quarterly, IX (June, 1958), 126-143.

21. Brown, David A. "Compensating the Innovator," Industrial Research, IV (February, 1962), 20-24.

22. Bucher, George C., and Richard C. Gray. "The Principles of Motivation and How to Apply Them," Research Management, XIV (May, 1971), 12-23.

23. Bush, Vannevar. "Of Inventions and Inventors," Research Management, XIV (July, 1971), 27-36.

24. Cahn, Richard W. "Case Histories of Innovations," Nature, CCXXV (February 21, 1970), 693-695.

25. Cairl, Jack G. and Patrick R. Gallagher, Jr. "Government, Science, and Technology: A Bibliographical Essay," Public Administration Review, XXVIII (July-August, 1968), 373-381.

26. Caldwell, Lynton K. "Managing the Scientific Super-Culture: The Task of Educational Preparation," Public Administration Review, XXVII (June, 1967), 128-133.

27. Carpenter, Richard A. "Information for Decisions in Environmental Policy," Research Management, XIV (March, 1971), 27-33.

28. Cole, Stephen and Jonathan R. Cole. "Scientific Output and Recognition: A Study in the Operation of the Reward System in Science," American Sociological Review, XXXII (June, 1967), 377-390.

29. ________. "Visibility and the Structural Bases of Scientific Research," American Sociological Review, XXXIII (June, 1968), 397-413.

30. Collier, Abram T. "Business Leadership and a Creative Society," Harvard Business Review, XLVI (January-February, 1968), 154-168. Reprint and retrospective of an article originally published in 1953.

31. Craik, Kenneth J. W. "Theory of the Human Operator in Control Systems: I. The Operator as an Engineering System," British Journal of Psychology, XXXVIII (September, 1947), 56-61.

32. ________. "Theory of the Human Operator in Control Systems: II. Man as an Element in a Control System," British Journal of Psychology, XXXVIII (March, 1948), 142-148.

33. Crane, Diana. "Scientists at Major and Minor Universities: A Study of Productivity and Recognition," American Sociological Review, XXIX (October, 1965), 699-714.

34. ________. "Social Structure in a Group of Scientists: A Test of the 'Invisible College' Hypothesis," American Sociological Review, XXXIV (June, 1969), 335-352.

35. Daedalus. "Creativity and Learning," Daedalus, XCIV (Summer, 1965), entire issue.

36. Dean, Burton V. "Application of Operations Research to Managerial Decision Making," Administrative Science Quarterly, III (December, 1958), 412-428.

37. DeBeer, Gavin. "Other Men's Shoulders," Annals of Science, XX (December, 1964), 303-322.

38. de Jouvenal, Bertrand. "The Technocratic Age," Bulletin of the Atomic Scientists, XX (October, 1964), 27-29.

39. Dessauer, John H. "How A Large Corporation Motivates Its Research and Development People," Research Management, XIV (May, 1971), 51-55.

40. Diebold, John T. "Scientific Management and Human Relations," Advanced Management, XVII (February, 1952), 12-14.

41. Dinsmore, Robert P. "Improving the Professional Environment of Research People: Human Relations Are Important," Research Management, I (Summer, 1958), 101-112.

42. Doblin, J. "Toward a Science of Design," Professional Engineer, XLI (July, 1971), 28-32.

43. Donovan, James A. "The Automation of Government," Saturday Review, XLVII (December 12, 1964), 23-24.

44. Dorfman, Robert. "Operations Research," American Economic Review, L (September, 1960), 575-623.

45. Dror, Yehezkel. "Muddling Through--'Science or Inertia'?" Public Administration Review, XXIV (September, 1964), 153-157. A critical analysis of the incremental-change thesis of Charles E. Lindblom developed in "The Science of Muddling Through," Public Administration Review, XIX (Spring, 1959), 79-88.

46. Drucker, Peter F. "Management Science and the Manager," Management Science, I (January, 1955), 115-126.

47. ________. "Potentials of Management Science," Harvard Business Review, XXXVII (January-February, 1959), 25-30; 146-150.

48. Dubos, Rene. "We Are Slaves to Fashion in Research!" Scientific Research, II (January, 1967), 36-37; 54.

49. Dutton, James M. and Richard E. Walton. "Operational Research and the Behavioral Sciences," Operational Research Quarterly, XV (September, 1964), 207-217.

50. Eschenfelder, Alfred H. "Creating an Environment for Creativity," Research Management, XI (July, 1968), 231-240.

51. Feinberg, Mortimer R. "Fourteen Suggestions for Managing Scientific Creativity," Research Management, XI (March, 1968), 83-92.

52. Forrester, Jay W. "Industrial Dynamics--A Major Breakthrough for Decision-Makers," Harvard Business Review, XXVI (July-August, 1958), 36-66.

53. Foster, R. N. "Organize for Technology Transfer," Harvard Business Review, XLIX (November-December, 1971), 110-120.

54. Frederick, Dolores A. "Motivating Scientists and Engineers," Industrial Research, IX (March, 1967), 86-91.

55. Freeman, Linton. "Two Problems in Computer Simulation in the Social and Behavioral Sciences," Social Science Information, X (February, 1971), 103-109.

56. Fried, J. H. E. "Social and Economic Role of Engineers and Technicians," International Labour Review, LV (June, 1947), 512-537.

57. Gaddis, Paul O. "The Project Manager," Harvard Business Review, XXXVII (May-June, 1959), 89-97.

58. Galloway, E.C. "Evaluating R & D Performance--Keep It Simple," Research Management, XIV (March, 1971), 50-58.

59. George, Frank H. "Educational Technology and the Systems Approach," Cybernetica, XIII (Number 2, 1970), 105-114.

60. Gershinowitz, Harold. "National Differences in Styles of Research Management," Research Management, XII (May, 1969), 205-218.

61. ________. "Sustaining Creativity Against Organizational Pressures," Research Management, III (Spring, 1960), 49-56.

62. Getzels, Jacob W. and M. Csikszentmihalyi. "Scientific Creativity," Science Journal, III (September, 1967), 80-84.

63. Gibson, Ralph E. "A Systems Approach to Research Management, Part I: Scientific Research," Research Management, V (July, 1962), 215-228; "Part II: Technology and Its Environment," Ibid., V (November, 1962), 423-437; "Part III: The Operation and Management of Research and Development Organizations," Ibid., VI (January, 1963), 15-27.

64. Giddings, Glenn W. and Lowell W. Steele. "Personal Audits and Their Effect upon Research Productivity," Research Management, II (Winter, 1959), 231-240.

65. Gladstone, Edgar J. "How a Systems Analysis Group Helps R & D Management," Research Management, XIV (November, 1971), 71.

66. Glicksman, Maurice. "R & D in Japan--A Future Threat Will Challenge the U.S.," Research Management, XIV (January, 1971), 28-37.

67. Gomersall, Earl R. "Current and Future Factors Affecting the Motivation of Scientists, Engineers and Technicians," Research Management, XIV (May, 1971), 43-50.

68. Gorry, G. Anthony, and Michael S. Scott Morton. "A Framework for Management Information Systems," Sloan Management Review, XIII (Fall, 1971), 55-70.

69. Gray, George W. "The Nobel Prizes," Scientific American, CLXXXI (December, 1949), 11-17.

70. Hallenberg, Edward X. "Dual Advancement Ladder Provides Unique Recognition for the Scientist," Research Management, XIII (May, 1970), 221-227.

71. Hand, Herbert H. "The Mystery of Executive Education," Business Horizons, XIV (June, 1971), 35-38.

72. Handy, Charles B. "Exploding the Management Education Myth," European Business, Number 29 (Spring, 1971), 79-86.

73. Harder, Eugene L. "Computers and Automation," Impact of Science on Society, X (Number 1, 1960), 3-15.

74. Harrington, Michael. "The Social-Industrial Complex," Harper's Magazine, CCXXXV (November, 1967), 55-60.

75. Haskins, Caryl P. "Science and the Whole Man," Daedalus, LXXXVI (September, 1956), 113-121.

76. Henderson, H. "Computers at the Crossroads," Futurist, V (August, 1971), 151-154.

77. Hertz, David B. "The Management of Innovation," Management Review, (April, 1965), 49-52.

78. Hill, Lawrence S. "Computers in R & D and Engineering--Proceed with Care," Research Management, XIII (May, 1970), 191-200.

79. Hitch, Charles J. "The New Approach to Management in the U.S. Defense Department," Management Science, IX (October, 1962), 1-8.

80. Hurni, Merlin L. "Observations on the Role of Business Research as an Aid to Managers," Cybernetica, III (Number 3, 1960), 234-244.

81. Ingle, Dwight J. "Psychological Barriers in Research," American Scientist, XLII (April, 1954), 283-293.

82. Johnson, Howard W. "Education for Management and Technology in the 1970's," Science, CLX (May 10, 1968), 620-627.

83. Johnson, Richard A., Fremont E. Kast, and James E. Rosenzweig. "Systems Theory and Management," Management Science, X (January, 1964), 367-385.

84. Jones, Graham. "The Manager's Role is Vital," New Scientist, LII (December 30, 1971), 260-262.

85. Kadanoff, Les P. "From Simulation Model to Public Policy," American Scientist, LX (January-February, 1972), 74-79.

86. Kassem, M. Sami and John S. Efroymson. "Russia's Changing Science and Technology Policies," Research Management, XIV (July, 1971), 37-46.

87. Kassem, M. Sami and W.B. Wagner. "Scientists Who Migrate in Teams--And How to Manage Them," Technology Review, LXXIII (December, 1970), 29-33.

88. Kast, Fremont E. "Management Concepts and Practice--European Style," Business Horizons, VII (Winter, 1964), 25-36.

89. King, Alexander. "Management as a Technology," Impact of Science on Society, VIII (Number 2, 1957), 65-85.

90. King, Robert W. "Whither the Technological State?" Politcal Science Quarterly, LXV (March, 1950), 55-67.

91. Kittel, Charles. "The Nature and Development of Operations Research," Science, CV (February 7, 1947), 150-153.

92. Kolcum, Edward H. "Litton Investing in Greek Future," Aviation Week and Space Technology, LXXXIX (August 5, 1968), 71-77.

93. Kubie, Lawrence S. "The Fostering of Creative Scientific Productivity," Daedalus, XCI (Spring, 1962), 294-309.

94. Lakhtin, George A. "Operational Research Methods in the Management of Scientific Research," Minerva, VI (Summer, 1968), 524-540.

95. Landis, Fred. "What Makes Technical Men Happy and Productive?" Research Management, XIV (May, 1971), 24-42.

96. Langrod, Georges. "The Rationalization of Methods and Means of Action in Public Administration," International Social Science Journal, XII (Number 3, 1960), 369-384.

97. Leavitt, Harold J. and Thomas L. Whisler. "Management in the 1980's," Harvard Business Review, XXXVI (November-December, 1958), 41-48.

98. Lesourne, Jacques. "The Place of Operational Research in the Development of Modern Society," Impact of Science on Society, IX (Number 4, 1959), 197-209.

99. Lessing, Lawrence. "Systems Engineering Invades the City," Fortune, LXXVII (January, 1968), 154.

100. Licklider, J. C. R. "The System System," in Human Factors in Technology, ed. by Edward Bennet, et al. New York: McGraw-Hill, 1963, 627-641.

101. Likert, Rensis. "Measuring Organizational Performance," Harvard Business Review, XXXVI (March-April, 1958), 41-50.

102. Lindblom, Charles E. "The Science of Muddling Through," Public Administration Review, XIX (Spring, 1959), 79-88.

103. Lindsay, Edwin M. "Financial Management of R & D: Planning and Budgeting, Project Authorization and Financial Reporting," Research Management, XIV (July, 1971), 58-66.

104. Littel, Richard J. "The Nobel Establishment: A Rare Glimpse," Scientific Research, II (October, 1967), 48-50; 53-56.

105. Lowry, W. Kenneth. "Use of Computers in Information Systems," Science, CLXXV (February 25, 1972), 841-846.

106. Lundstedt, Sven. "Administrative Leadership and the Use of Social Power," Public Administration Review, XXV (June, 1965), 156-160.

107. LuRens, Matthias E. "Practicing Management Theory," Public Administration Review, XVIII (Summer, 1958), 223-230.

108. Maass, Arthur. "System Design and the Political Process: A General Statement," in Design of Water Resource Systems--New Techniques for Relating Economic Objectives, Engineering Analysis, and Governmental Planning, by Arthur Maass, et al. Cambridge, Massachusetts: Harvard University Press, 1962, 565-604.

109. Mace, Cecil A. "Thinking and Discovery in Science," New Scientist, IV (July 24, 1958), 488-490.

110. Makridakis, Spyros. "The Whys and Wherefores of the Systems Approach," European Business, Number 30 (Summer, 1971), 64-70.

111. Management Consultant. "The Challenge of Technology to Management," Management Consultant, 1963 Series, Number 1, 4. Reprinted in Public Administration News, XIII, Section II (August, 1963).

112. Marcus, Philip M. and Dora Cafogna. "Control in Modern Organizations," Public Administration Review, XXV (June, 1965), 121-127.

113. Marvyama, Magoroh. "Toward Non-Hierarchical Administration Through Computers," Cybernetica, XI (Number 2, 1968), 99-110.

114. Maynard, Harold B. "Scientific Management Abroad," Advanced Management, XVIII (May, 1953), 18-21.

115. Meltzer, Leo. "Scientific Productivity in Organizational Settings," Journal of Social Issues, XII (Number 2, 1956), 32-40.

116. Merton, Robert K. "Behavior Patterns of Scientists," American Scientist, LVII (Spring, 1969), 1-23.

117. Merton, Robert K. "The Matthew Effect in Science," Science, CLIX (January 5, 1968), 56-63.

118. ________. "Priorities in Scientific Discovery: A Chapter in the Sociology of Science," American Sociological Review, XXII (December, 1957), 635-659.

119. Minas, J. Sayer. "Formalism, Realism, and Management Science," Management Science, III (October, 1956), 9-14.

120. Palmer, F. M. "Process Research--Who Should Do It? Where Should It Be Done?" Research Management, XIV (July, 1971), 67-74.

121. Papo, Maurice. "How to Establish and Operate Multinational Labs," Research Management, XIV (January, 1971), 12-19.

122. Pennycuick, Kenneth. "Industrial Diagnosis," Impact of Science on Society, IX (Number 1, 1958), 3-22.

123. Person, Harlow S. "The Development and Influence of Scientific Management," Advanced Management Journal, XVII (October, 1952), 2-5.

124. Pierce, John R. "Freedom in Research," Science, CXXX (September 4, 1959), 540-542.

125. Pinnell, Charles. "Application of Scientific Management Techniques to College and University Administration," Association for Educational Data Systems Journal, II (September, 1968), 19-32.

126. Potter, B. V. "Effective Information and Technology Transfer in Multinational R & D," Research Management, XIV (January, 1971), 20-27.

127. Price, William J. and Lawrence W. Bass. "Scientific Research and the Innovative Process," Science, CLXIV (May 16, 1969), 802-806.

128. Randers, Jorgen and Donnella Meadows. "The Carrying Capacity of the Globe," Sloan Management Review, XIII (Winter, 1972), 11-27.

129. Rechtin, Eberhardt. "Systems Engineering--But Isn't That What I've Been Doing All Along?" Astronautics and Aeronautics, VI (June, 1968), 70-74.

130. Reich, Irving. "Creativity in Research Organizations," Research Management, III (Winter, 1960), 217-225.

131. Research Management. "Two International Research Organizations in Formative Stages," Research Management, XIV (January, 1971), 70-74.

132. Retterer, Ray W. "Computers and Communications Provide New Conception in Scientific Management," Advanced Management Journal, XIX (October, 1964), 38-41.

133. Roberts, Edward B. "The Myths of Research Management," Science and Technology, LXXX (August, 1968), 40-46.

134. Roy, Robert. "Applied Research Needs New Funding Scheme," Chemical and Engineering News, XLIX (August 2, 1971), 12-17.

135. Royer, George L. "Salary Administration of Research Personnel," Research Management, I (Summer, 1958), 113-128.

136. Sampson, Carol. "The Nobel Prize," Industrial Research, VII (January, 1965), 56-60.

137. Schumacher, David. "Cooperation of Government, Science, and Industry in R &D--A Systems View," Policy Sciences, II (Summer, 1961), 279-286.

138. Schwartz, Melvin. "The Conflict between Productivity and Creativity in Modern Day Physics," American Behavioral Scientist, VI (December, 1962), 35-36.

139. Science Journal. "Scientists and Their Salaries," Science Journal, I (May, 1965), 81-85.

140. Secrist, Horace A. "Motivating the Industrial Research Scientist," Research Management, III (Spring, 1960), 57-64.

141. Seifert, Howard S. "Can We Decrease Our Entropy?" American Scientist, LXIX (June, 1961), 124A-134A.

142. Shell, Richard L., and David F. Stelzer. "Systems Analysis: Aid to Decision Making," Business Horizons, XIV (December, 1971), 67-72.

143. Shepard, Herbert A. "Applied Behavioral Science and R & D Effectiveness," Research Management, XI (September, 1968), 305-321.

144. ________. "Major Researches in Creativity," Research Management, II (Winter, 1959), 203-220.

145. Singh, Paramjit. "Management Styles and Philosophies Abroad," Research Management, XIV (January, 1971), 64-69.

146. Skolimowski, Henryk. "Towards a Humanistic Technology," Research Management, XIV (September, 1971), 10-23.

147. Soltanoff, Louis. "The Innovation Myth," Industrial Research, XIII (August, 1971), 44-46.

148. Spaulding, Asa T., Jr. "Is the Total System Concept Practical?" Systems and Procedures Journal, XV (January, 1964), 28-32.

149. Sprague, Philip A. "Man as a Research Tool," Industrial Research, IV (June, 1962), 52-56.

150. Stratton, Julius A. "Science and the Process of Management," Research Management, VII (March, 1964), 79-90.

151. Tabb, William K. "Data Retrieval Systems, the University, and State Decision Making," Public Administration Review, XXXI (July-August, 1971), 435-440.

152. Taton, Rene. "Design and Chance in Discovery and Invention," Impact of Science on Society, VI (December, 1955), 208-232.

153. Thompson, James D. and Frederick L. Bates. "Technology, Organization, and Administration," Administrative Quarterly, II (December, 1957), 325-343.

154. Tribus, Myron. "National Problems--A Challenge to Industrial R & D," Research Management, XIV (March, 1971), 24-26.

155. Utterback, James M. "The Process of Innovation: A Study of the Organization and Development of Ideas for New Scientific Instruments," IEEE Transactions on Engineering Management, XVIII (November, 1971), 124-131.

156. ______. "The Process of Technological Innovation within the Firm," Academy of Management Journal, XIV (March, 1971), 75-88.

157. Veillette, Paul T. "The Impact of Mechanization on Administration," Public Administration Review, XVII (Autumn, 1957), 231-237.

158. Verhulst, Michel. "Mathematics for Managers," Impact of Science on Society, VIII (March, 1957), 16-31.

159. Wakelin, J. H., Jr. "Technological Horizons of Management Science," United States Department of Commerce News, (March 23, 1971), 1-9.

160. Weinland, Clarence E. "Creative Thought in Scientific Research," Scientific Monthly, LXXV (December, 1952), 350-354.

161. Whisler, Thomas L. "Manager and the Computer," Journal of Accounting, CXIX (January, 1965), 27-32.

162. White, Lynn, Jr. "The Act of Invention: Causes, Contexts, Continuities, and Consequences," Technology and Culture, III (Fall, 1962), 486-500.

163. Wickesberg, Albert K. and Thomas C. Cronin. "Management by Task Force," Harvard Business Review, XL (November-December, 1962), 111-118.

164. Winthrop, Henry. "Total Environmental Management: An Approach to the Dilemma of the Affluent Society," Futures, II (December, 1970), 332-340.

165. Woodward, F. N. "Organized Cooperative Research in Europe," Research Management, XIV (January, 1971), 55-63.

166. Zuckerman, Harriet. "Nobel Laureates in Science: Patterns of Productivity, Collaboration, and Authorship," American Sociological Review, XXXII (June, 1967), 391-403.

167. Zvegintzov, M, "Management in a Modern Scientific and Technological Age," Impact of Science on Society, XI (Number 1, 1961), 53-73.

General References: Books

168. Abt Associates, Inc. A Survey of Systems Analysis Models and Their Potential Applications. Washington, D.C.: Technology Utilization Division, National Aeronautics and Space Administration, 1967.

169. Ackoff, Russell L. in collaboration with Shiv K. Gupta and J. Sayer Minas. Scientific Method: Optimizing Applied Research Decisions. New York: Wiley, 1962, 464.

170. Aerospace Industries Association. Industry Funded Research and Development. Washington, D.C.: Aerospace Industries Association, 1971, 10.

171. Aitken, Hugh G. J. Taylorism at Watertown Arsenal: Scientific Management in Action, 1908-1915. Cambridge, Massachusetts: Harvard University Press, 1960, 269.

172. Allen, Louis A. The Management Profession. New York: McGraw-Hill, 1964, 375.

173. Allison, David, ed. The R & D Game: Technical Men, Technical Managers, and Research Productivity. Cambridge, Massachusetts: M.I.T. Press, 1969, 322.

174. Appley, Lawrence A. The Management Evolution. New York: American Management Association, 1963, 304.

175. Armytage, Walter H. G. The Rise of the Technocrats--A Social History. London: Routeledge and Keegan Paul; Toronto: University of Toronto Press, 1965, 448.

176. Basiuk, Victor. The Impact of Technology in the Next Decades. Reprint, Institute for the Study of Science in Human Affairs. New York: Columbia University, 1970, 42.

177. Baumgartner, John S. Project Management. Homewood, Illinois: Irwin, 1968, 185.

178. Bienstock, Gregory, Soloman M. Schwarz, and Aaron Yugow. Management in Russian Industry and Agriculture. London and New York: Oxford University Press, 1948, 198.

179. Black, G. The Application of Systems Analysis to Government Operations. New York: Praeger, 1968, 202.

180. Blake, Robert R. and Jane S. Mouton. The Managerial Grid: Key Orientations for Achieving Production through People. Houston: Gulf, 1964, 340.

181. Blumstein, A., Kamrass, M., and Weiss, A. B., eds. Systems Analysis for Social Problems. Washington, D.C.: Washington Operations Research Council, 1969, 331.

182. Bobrow, Davis B. and Judah L. Schwartz, eds. Computers and the Policy-Making Community: Applications to International Relations. Englewood Cliffs, New Jersey: Prentice-Hall, 1968, 374.

183. Boguslaw, Robert. The New Utopians--A Study of System Design and Social Change. Englewood Cliffs, New Jersey: Prentice-Hall, 1965, 213.

184. Bright, James R., ed. Research, Development, and Technological Innovation: An Introduction. Homewood, Illinois: Richard D. Irwin, 1964, 783.

185. Brown, Murray. On the Theory and Measurement of Technological Change. Cambridge, England: Cambridge University Press, 1966, 214.

186. Buckley, Walter, ed. Modern Systems Research for the Behavioral Scientist: A Sourcebook. Chicago: Aldine, 1968, 525.

187. Burnham, James. The Managerial Revolution: What Is Happening in the World. New York: John Day, 1941, 285.

188. Burns, Tom and George M. Stalker. The Management of Innovation. Chicago: Quadrangle, 1962, 269.

189. Cetron, Marvin J. and James D. Goldhar, eds. The Science of Managing Organized Technology. Volumes III and IV. New York and London: Gordon and Breach, 1971, 789.

190. Cetron, Marvin J., R. Isenson, J. N. Johnson, A. B. Nuft, and H. A. Wells. Technical Resource Management: Quantitative Methods. Cambridge, Massachusetts: M.I.T. Press, 1969, 236.

191. Chartrand, R. L. Systems Technology Applied to Social and Community Problems. New York: Spartan Books, 1970, 496.

192. Churchman, C. West. The Systems Approach. New York: Delacorte Press, 1968, 243.

193. Churchman, C. West, Russell L. Ackoff, and E. Leonard Arnoff. Introduction to Operations Research. New York: Wiley, 1959, 645.

194. Churchman, C. West and Michel Verhulst. Management Sciences, Models, and Techniques, Volumes 1-2. Proceedings of the Sixth International Meeting of the Institute of Management Sciences, 1959. New York: Pergamon, 1960, 1133.

195. Clough, Donald J. Concepts in Management Science. Englewood Cliffs, New Jersey: Prentice-Hall, 1963, 425.

196. Coler, Myron A., ed. Essays on Creativity in the Sciences. New York: New York University Press, 1964, 256.

197. Daiute, Robert J. Scientific Management and Human Relations: Ideas, Topics, Readings. New York: Holt, Rinehart, and Winston, 1964, 191.

198. Danhof, Clarence H. Technology Transfer by People Transfer: A Case Study. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1969, 15.

199. Davies, Robert W. The Development of the Soviet Budgetary System. Cambridge, England: University Press, 1958, 373.

200. Dean, Burton V., ed. Operations Research in Research and Development. New York: Wiley, 1963, 289.

201. Defense Documentation Center. A DDC Bibliography on Cost/Benefits of Technical Information Services and Technology Transfer. Washington, D.C.: Defense Documentation Center, 1968, 80.

202. Deutsch, Karl. The Nerves of Government. New York: Free Press, 1963, 31[illegible].

203. Diebold Group, Inc. Private Enterprise in a Post-Industrial Society: Education, Technology, and Business--A Case Study of Business in the Future. New York: Praeger, 1971, 107.

204. Doctors, Samuel I. The NASA Technology Transfer Program: An Evaluation of the Dissemination System. New York: Praeger, 1971, 225.

205. ________. The Role of Federal Agencies in Technology Transfer. Cambridge, Massachusetts: M.I.T. Press, 1969, 230.

206. Drucker, Peter F. Technology, Management, and Society. New York: Harper and Row, 1970, 212.

207 Ellul, Jacques. The Technological Society. Translated by John Wilkinson. New York: Knopf, 1964, 449.

208. Emery, James C. Organizational Planning and Control Systems Theory and Technology. New York: Macmillan, 1969, 166.

209. Feigenbaum, Edward A. and Julian Feldman, eds. Computers and Thought. New York: McGraw-Hill, 1963, 535.

210. Fields, Gordon B. The Influence of Insurance on Technological Development. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1969, 38.

211. Flagle, Charles D., William H. Huggins, and Robert H. Roy. Operations Research and Systems Engineering. Baltimore: Johns Hopkins Press, 1960, 889.

212. Forrester, Jay W. Industrial Dynamics. Cambridge, Massachusetts: M.I.T. Press, 1964, 464.

213. ________. Principles of Systems. Second Preliminary Edition. Cambridge, Massachusetts: Wright-Allen, 1968, 392.

214. ________. Urban Dynamics. Cambridge, Massachusetts: M.I.T. Press, 1969, 285.

215. Forsythe, Eugene J. and Palmer Pilcher. Management Science--A New Organizational Dimension. Detroit: Institute of Labor and Industrial Relations, Wayne State University, 1959, 117.

216. Galbraith, John K. The New Industrial State. Boston: Houghton Mifflin, 1967, 427.

217. Gerstenfeld, Arthur. Effective Management of Research and Development. Reading, Massachusetts: Addison-Wesley, 1970, 150.

218. Gilfillian, S. C. Invention and the Patent System. Washington, D.C.: U.S. Government Printing Office, 1964, 246.

219. Goldsmith, M., ed. Technological Innovation and the Economy. New York: Wiley-Interscience, 1970, 292.

220. Granick, David. The European Executive. Garden City, New York: Doubleday, 1962, 384.

221. ________. The Red Executive. Garden City, New York: Doubleday, 1960, 334.

222. Greenberger, Martin, ed. Management and the Computer of the Future. Cambridge, Massachusetts: M.I.T. Press; New York: Wiley, 1962, 340.

223. Greenwood, William T., ed. Management and Organizational Behavior Theories: An Interdisciplinary Approach. Cincinnati: Southwestern, 1965, 890.

224. Gross, Bertram M. The Managing of Organizations. Two Volumes. New York: Free Press of Glencoe, 1964, 971.

225. Gruber, William H. and Donald G. Marquis, eds. Factors in the Transfer of Technology. Cambridge, Massachusetts: M.I.T. Press, 1969, 289.

226. Gulick, Luther and Lyndall F. Urwick, eds. Papers on the Science of Administration. New York: Institute of Public Administration, Columbia University, 1937, 195.

227. Haber, Samuel. Efficiency and Uplift: Scientific Management in the Progressive Era, 1890-1920. Chicago: University of Chicago Press, 1964, 181.

228. Hainer, Raymond M., Sherman Kingsbury, and David B. Gleicher, eds. Uncertainty in Research Management, and New Product Development. New York: Reinhold, 1967, 234.

229. Hamberg, Daniel. R & D: Essays on the Economics of Research and Development. New York: Random House, 1963, 170.

230. Hartman, Heinz. Authority and Organization in German Management. Princeton, New Jersey: Princeton University Press, 1959, 318.

231. Harvard University Program on Technology and Society. Implications of Computer Technology. Cambridge, Massachusetts: Harvard University Press, 1971, 56.

232. Heller, T.S., J.S. Gilmore, and T.D. Browne. Technology Transfer--A Selected Bibliography. Denver, Colorado: University of Denver, 1971, 181.

233. Hertz, David B. New Power For Management: Computer Systems and Management Science. New York: McGraw-Hill, 1969, 208.

234. Hill, Karl, ed. The Management of Scientists. Boston: Beacon Press, 1964, 143.

235. Hower, Ralph M. and Charles D. Orth, III. Managers and Scientists: Some Problems in Industrial Research Organizations. Boston: Harvard School of Business Administration, 1963, 323.

236. India. Council for Scientific and Industrial Research. Research Survey and Planning Organization. Index to Literature on Science of Science. Volume 5. Rafi Marg, New Delhi: Council for Scientific and Industrial Research, 1969, 31.

237. Johnson, Richard A., Fremont E. Kast, and James E. Rosenzweig. The Theory and Management of Systems. Revised Edition. New York: McGraw-Hill, 1967, 513.

238. Kast, Fremont E. and James E. Rosenzweig. Management in the Space Age: An Analysis of the Concept of Weapon System Management and Its Non-Military Applications. New York: Exposition Press, 1962, 183.

239. Kast, Fremont E. and James E. Rosenzweig, eds. Science, Technology, and Management. New York: McGraw-Hill, 1963, 384.

240. Korol, Alexander G. Soviet Research and Development. Cambridge, Massachusetts: M.I.T. Press, 1965, 375.

241. Landau, Martin, ed. Management Information Technology--Recent Advances and Implications for Public Administration: A Symposium Based upon Papers Presented at the 1964 National Conference on Public Administration, New York City, April 17, 1964. American Society for Public Administration. Philadelphia: University of Pennsylvania-Fels Institute of Local and State Government, 1965, 53.

242. Leonard, William P. The Management Audit: An Appraisal of Management Methods and Performance. Englewood Cliffs, New Jersey: Prentice-Hall, 1962, 238.

243. Leontief, Wassily. Input-Output Economics. New York: Oxford University Press, 1966, 257.

244. Lesher, Richard L. and George J. Howick. Assessing Technology Transfer. Washington, D.C.: Office of Technology Litigation, National Aeronautics and Space Administration, 1966, 121.

245. Likert, Rensis. New Patterns of Management. New York: McGraw-Hill, 1961, 229.

246. Lyden, Fremont J. and Ernest G. Miller, eds. Planning Programming Budgeting: A Systems Approach to Management. Chicago: Markham, 1968, 443.

247. McCamy, James L. Science and Public Administration. University: University of Alabama Press, 1960, 218.

248. McDonough, Adrian M. and Leonard D. Garrett. Management Systems: Working Concepts and Practices. Homewood, Illinois: Richard D. Irwin, 1965, 311.

249. Malcolm, Donald G., Alan J. Rowe, and Lorimer F. McConnell, eds. Management Control Systems. New York: Wiley, 1960, 375.

250. Mansfield, Edwin. Industrial Research and Technological Innovation. New York: Norton, 1968, 235.

251. Martindell, Jackson. The Scientific Appraisal of Management--A Study of Business Practices of Well-Managed Companies. New York: Harper, 1950, 300.

252. Moder, Joseph I. and Cecil R. Phillips. Project Management with CPM and PERT. Second Edition. New York: Van Nostrand, 1970, 352.

253. Morris, William T. Management Science in Action. Homewood, Illinois: Richard D. Irwin, 1963, 308.

254. Morse, Philip M., ed. Operations Research for Public Systems. Cambridge, Massachusetts: M.I.T. Press, 1967, 212.

255. Morse, Phillip M. and George E. Kimball. Methods of Operations Research. New York: Wiley; Cambridge, Massachusetts: M.I.T. Press, 1958, 158.

256. Mottur, Ellis R. Conversion of Scientific and Technical Resources: Economic Challenge-Social Opportunity. Washington, D.C.: Program of Policy Studies in Science and Technology, George Washington University, 1971, 201.

257. Myers, Sumner and Donald G. Marquis. Successful Industrial Innovations: A Study of Factors Underlying Innovation in Selected Firms. Washington, D.C.: National Science Foundation, 1969, 117. (NSF 69-17)

258. Nadworny, Milton J. Scientific Management and the Union, 1900-1932: A Historical Analysis. Cambridge, Massachusetts: Harvard University Press, 1955, 187.

259. National Academy of Engineering. The Process of Technological Innovation. Washington, D.C.: National Academy of Sciences, 1969, 103.

260. National Academy of Sciences - National Research Council. Committee on Operations Research. Operations Research with Special Reference to Non-Military Applications--A Comprehensive Scientific Aid to Executive Decisions. Washington, D.C.: National Research Council, 1951, 12.

261. National Science Foundation. Technology Transfer and Innovation. Washington, D.C.: National Science Foundation, 1967, 126.

262. Neuschel, Richard F. Management by System. Second Edition. New York: McGraw-Hill, 1960, 359.

263. Newman, William H. Administrative Action: The Techniques of Management and Organization. Second Edition. Englewood Cliffs, New Jersey: Prentice-Hall, 1963, 486.

264. Novick, David, ed. Program Budgeting: Program Analysis and the Federal Budget. Cambridge, Massachusetts: Harvard University Press, 1965, 382.

265. Optner, Stanford L. Systems Analysis for Business Management: A Systems Approach for Analyzing the Effectiveness of a Business. Englewood Cliffs, New Jersey: Prentice-Hall, 1960, 276.

266. Organization for Economic Cooperation and Development. Conditions for Success in Technological Innovation. Paris: OECD, 1971, 172.

267. Pelz, D.C. and F.M. Andrews. Scientists in Organizations: Productive Climates for Research and Development. New York: Wiley, 1966, 318.

268. Quade, E.S. and W.I. Boucher, eds. Systems Analysis and Policy Planning: Application to Defense. New York: American Elsevier, 1968, 453.

269. Ramo, Simon. Cure for Chaos: Fresh Solutions to Social Problems through the Systems Approach. New York: McKay, 1969, 116.

270. Raudsepp, Eugene. Managing Creative Scientists and Engineers. New York: Macmillan, 1963, 254.

271. Reagan, Michael D. The Managed Economy. New York: Oxford University Press, 1963, 288.

272. Redfield, Charles E. Communication in Management: The Theory and Practice of Administrative Communication. Chicago: University of Chicago Press, 1958, 314.

273. Reeves, E. Duer. Management of Industrial Research. New York: Reinhold, 1967, 207.

274. Richman, Barry M. Soviet Management: With Significant American Comparisons. Englewood Cliffs, New Jersey: Prentice-Hall, 1965, 288.

275. Roberts, Edward B. The Dynamics of Research and Development. New York: Harper and Row, 1964, 352.

276. Roethlisberger, Fritz J. and William J. Dickson. Management and the Worker: An Account of a Research Program Conducted by the Western Electric Company, Hawthorne Works, Chicago. Cambridge, Massachusetts: Harvard University Press, 1941, 615.

277. Rossman, Joseph. Industrial Creativity: The Psychology of the Inventor. Third Edition. New Hyde Park, New York: University Books, 1964, 252.

278. Rudwick, Bernard H. Systems Analysis for Effective Planning. New York: Wiley, 1969, 469.

279. Sasieni, Maurice, Arthur Yaspan, and Laurence Friedman. Operations Research--Methods and Problems. New York: Wiley, 1961, 316.

280. Schell, Erwin H. Technique of Administration: Administrative Proficiency in Business. Second Edition. New York: McGraw-Hill, 1951, 363.

281. Schmookler, Jacob. Invention and Economic Growth. Cambridge, Massachusetts: Harvard University Press, 1966, 332.

282. Schoderbek, Peter P., compiler with the editorial collaboration of Charles G. Schoderbek. Management Systems. New York: Wiley, 1971, 561.

283. Schultz, George P. and Thomas L. Whisler, eds. Management Organization and the Computer. New York: Free Press of Glencoe, 1961, 257.

284. Simon, Herbert A. The New Science of Management Decision. New York: Harper, 1960, 50.

285. Sovel, M. Terry. Technology Transfer and Utilization--Bibliography. Denver, Colorado: Denver University, 1969, 101.

286. Spencer, Daniel L. and Alexander Woroniak, eds. The Transfer of Technology to Developing Countries. New York: Praeger, 1968, 209.

287. Starr, Martin K., ed. Management Science: Executive Readings in Management Science. New York: Macmillan, 1965, 422.

288. Stoller, David S. Operations Research: Process and Strategy. Berkeley: University of California Press, 1964, 159.

289. Stover, Carl F., ed. The Technological Order. Detroit: Wayne State University Press, 1963, 280.

290. Summer, Charles E. and Jeremiah J. O'Connell, eds. The Managerial Mind: Science and Theory in Policy Decision. Homewood, Illinois: Richard D. Irwin, 1964, 760.

291. Taylor, Frederick W. Scientific Management, Comprising Shop Management, the Principles of Scientific Management, and Testimony before the Special House Committee. Foreword by Harlow S. Person. New York: Harper, 1947, 207, 144, 287 (three volumes in one).

292. Teichroew, Daniel. An Introduction to Management Science: Deterministic Models. New York: Wiley, 1964, 713.

293. Trudeau, Arthur G. Time, Tactics, and Technology. Washington, D.C.: Headquarters, Department of the Army, 1959, 67.

294. U.S. Congress. Senate. Select Committee on Small Business. Subcommittee on Science and Technology. Policy Planning for Technology Transfer. Report prepared for the Subcommittee by the Science Policy Research Division, Legislative Reference Service, Library of Congress, 90th Congress, 1st Session, April 6, 1967. Washington, D.C.: U.S. Government Printing Office, 1967, 183.

295. U.S. Congress. Senate. Select Committee on Small Business. Subcommittee on Science and Technology. Technology Transfer. Hearings before the Subcommittee to the 91st Congress, 2nd Session, February 10, 1970. Washington, D.C.: U.S. Government Printing Office, 1970, 262.

296. U.S. Federal Council for Science and Technology. Annual Report on Government Patent Policy. Washington, D.C.: Federal Council for Science and Technology, 1968, 83.

297. Von Bertalanffy, Ludwig. General System Theory: Foundations, Development, Applications. New York: Braziller, 1968, 189.

298. Webb, James E. Space Age Management: The Large-Scale Appraoch. New York: McGraw-Hill, 1969, 173.

299. White, Frederick A. American Industrial Research Laboratories. Washington, D.C.: Public Affairs Press, 1961, 227.

300. Wildavsky, Aaron. The Politics of the Budgetary Process. Boston and Toronto: Little, Brown, 1964, 216.

301. Wilson, George G., ed. Technological Development and Economic Growth. Bloomington: Division of Research, Indiana University School of Business, 1971, 254.

302. Woodward, Joan. Management and Technology. London: Her Majesty's Stationery Office, 1960, 40. (Problems of Progress in Industry Number 3)

303. Wu, Yuan-Li and Robert B. Sheeks. The Organization and Support of Scientific Research and Development in Mainland China. New York: Praeger, 1970, 592.

304. Young, Michael D. The Rise of the Meritocracy: 1870-2033. An Essay on Education and Equality. New York: Random House, 1959, 160.

LEADING QUESTIONS

1. How would you distinguish between the administration of scientific and technological activities within the government and the administration of general policies affecting the applications of science and technology?

2. How much of a nation's economic effort should be channeled into the advancement of science? By what criteria should allocations be made among sciences?

3. What is meant by the "bureaucratization" of science? Is this an inevitable concomitant of big science?

4. Should the administration of science be restricted to "scientists"? Can an "administrator" without science credentials administer science policy? What has been the experience in government? In industry? In hospitals? In universities?

5. What policy and operational problems arise from the interrelationships among universities, industrial establishments, professional groups, and various government agencies in the public administration of science? Are these relationships consistent with traditional concepts of governmental accountability and distinctions between public and private interests?

6. How have science and technology influenced the character of the administrative process generally? What are specific illustrations of technology in administration?

7. What aspects of administration have not yet been influenced significantly by science? In what respects could science most greatly benefit administration today? How does "management science" attempt to improve management?

8. Is "technocracy" primarily a consequence of the ambition or self-confidence of science professionals and engineers, or of popular ignorance, folly, or indifference? Are there other factors?

9. What should be the content of education for the administration of science policy, and how, when, and where should it be acquired? Is the same true for applied science?

10. Must the reconciliation of scientific and democratic values be undertaken in large measure through the administrative process, broadly construed? Would it not be enough to resolve differences through conferences and colloquia, or through public education toward a more adequate understanding of science?